2015 Catalog
Oxford Instruments X-Ray Technology

Power Supplies, Integrated Sources and X-ray Tubes

Shielded X-ray Tubes and Power Supplies

Radiation Shielded X-ray Tubes

Microfocus X-ray Sources

Glass X-ray Tubes with Window

Compact Integrated X-ray Sources

Integrated X-ray Sources

February / 2015

OXFORD INSTRUMENTS

The Business of Science®

2015 Catalog

February 2015

Oxford Instruments X-Ray Technology is a global leader in the design and manufacture of integrated X-ray solutions. Our products range from integrated X-ray sources to high voltage power supplies and individual X-ray tubes featuring high stability, high X-ray flux and small spot sizes.

For more than 30 years, Oxford Instruments has been the best choice for analytical, industrial and medical original equipment manufacturers who demand the highest quality X-ray solutions.

This catalog should be used as a general guide for our products. The drawings in the datasheets are typical. Please ask us for the exact outline drawings and detailed specifications of the products.

If you do not see the product you are looking for in this catalog, please ask us about it!

ISO 9001:2008 Certified and RoHS Compliant

Solving Customer Specific Issues Since 1980

2015 Catalog

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The Optima 93225 is the world's smallest 50kV, 50W integrated source.

The Optima 93225 consists of an integrated, programmable, compact design that contains our field proven X-ray tube technology, state-of-the-art high voltage power supply and digital controller. The 93225 simplifies communication and system integration without the need for high voltage cable connections, making it extremely reliable and cost-effective. It also comes standard with a Beryllium window.

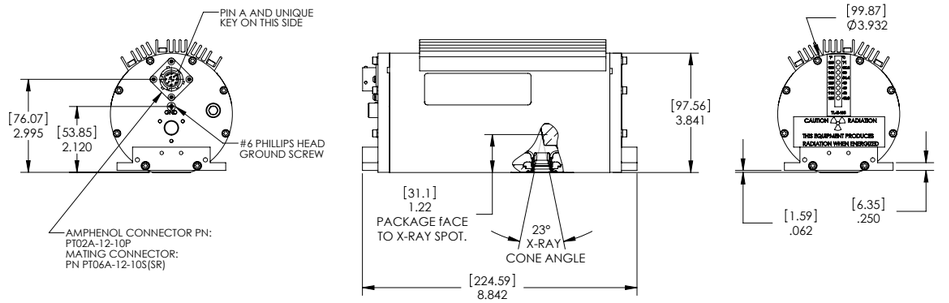
Features	Benefits
Stable X-ray output	Highly repeatable measurements
Intelligent controller	Enables maximum filament life
Advanced digital interface	Simplifies communication and system integration
Small, compact design	Easily integrates into your X-ray systems
Fully shielded package	Eliminates X-ray leakage

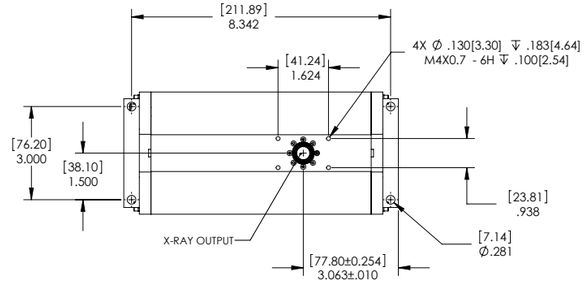
Applications

- XRF
- Inspection
- Mining and geology
- Densitometry
- Thickness gauging
- Regulatory (RoHS/WEEE)
- Art and archeometry
- R&D

Specifications	
Operating Voltage Range:	30-50kV
Maximum power:	50W
Beam current:	0-1.0mA
Target angle:	12°
Focal spot size (maximum):	X and Y <150µm
Focus to Object Distance (FOD):	31.1mm (1.22") (See drawing on next page)
Target material:	W
Window material and thickness:	Be, 125µm
Cone angle:	23°
Input voltage:	48 VDC ±5%
Input voltage ripple:	±5%
Maximum current (in-rush):	2A
Control signals:	See user manual (UM008)
Time to warm up to 50kV and 0.1mA:	<10 sec
Continuous stability:	kV <0.5%,
Cooling method:	Forced air @ 150 CFM
Max case operating temp:	55°C
Ambient operating temp:	0°C to 40°C
Radiation leakage:	<1.0µSv.hr $^{-1}$ @ 10cm (@ 50kV, 1.0mA)
Weight:	7.25kg
Storage conditions:	Storage conditions:-10°C to 55°C*
	*Note: Barometric Pressure: 50-106kPa Humidity: 10-90% (no condensation) Condensation on Be window will cause window corrosion, vacuum loss, and X-ray tube failure

Optima 93225 Integrated X-ray Source





PIN	SIGNAL	VOLTAGE
A	INTERLOCK IN	+48±5%
B	VCC	+48±5%
C	TXN FROM X-RAY SOURCE	0-5
D	RXN TO X-RAY SOURCE	0-5
E	RXP TO X-RAY SOURCE	0-5
F	NO CONNECT	
G	INTERLOCK OUT	0-48 OUTPUT 100mA MAX
H	GND	0
J	TXP FROM X-RAY SOURCE	0-5

DIMENSIONS: [mm]
Inches

The Trinity 9100004 is a 80kV, 33µm, 40 Watt integrated X-ray source designed for high resolution imaging applications, making it ideal for industrial inspection and non-destructive testing applications including PCB assembly, battery, plastic, metal and mechanical parts inspection, yet is versatile enough for medical imaging applications.

The Trinity design delivers high precision measurements free of distortion by utilizing our highly stable, high-intensity x-ray tube technology coupled with our high voltage power supply and controller. Configured in a compact, programmable package the Trinity system simplifies communications and system integration without the need for high voltage cable connections or additional shielding, making it extremely reliable and cost-efficient. Side window and end window orientations available.

Benefits

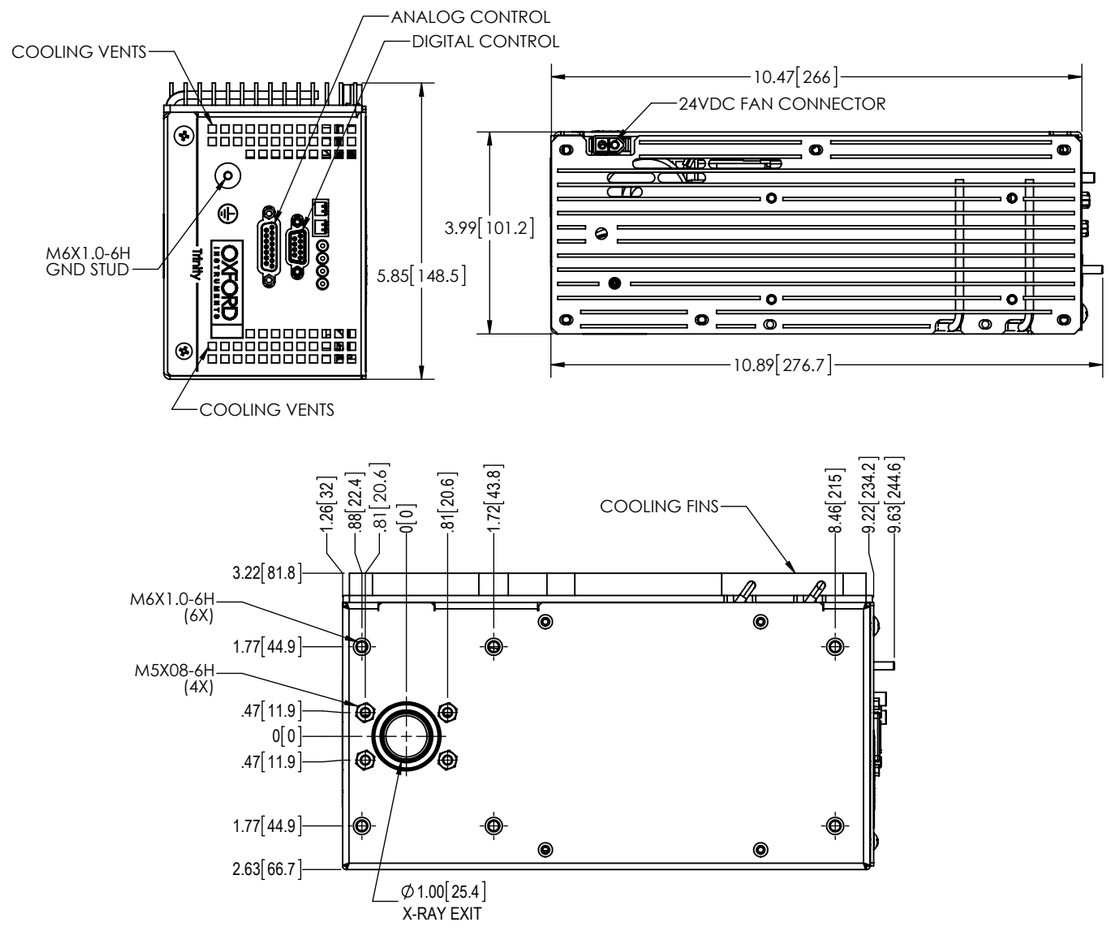
- Small, stable spot delivers distortion free measurements
- Compact, programmable, integrated package enables ease of installation and improved reliability
- XT proprietary shielding minimizes weight while ensuring extremely low radiation leakage
- LED indicators provide constant system status
- Fully lead-free and RoHS compliant

Applications

- Medical Imaging
- Inspection of printed circuit boards and electronic devices
- Nondestructive testing of plastic, metal and mechanical parts
- CT imaging for life sciences and industrial inspection applications

Specifications	
Operating Voltage Range:	20-80kV
Maximum Power:	40W
Maximum Beam Current:	10-500µA
Target Material:	W
Focal Spot Size:	33µm (Nominal CEI/IEC 60336:2005)
Cone of Illumination:	37°
Spot to Window Spacing (FOD):	27mm ± 1mm
Window Material & Thickness:	1.40 mm (0.055") Glass & 3.60mm (0.142") Polystyrene
Accuracy:	kV: < 0.50% µA: < 1.0%
Flux Stability:	≤ 0.2% over 4-hour period
Rise Time:	≤ 200 ms (from standby)
Duty Cycle:	Continuous
Ripple:	1% RMS @ 80kV, 500µA
Temperature Coefficient:	1000ppm/°C
Temperature Conditions:	Operating: Maximum 55°C at tube heat sink Storage: -10°C to 50°C
Humidity:	15°C to 40°C ; 0-95% RH up to 5,000ft
Method of Cooling:	External cooling required and directed at the unit at 100 CFM
Thermal Cut-Off:	55°C ± 3°C at tube heat sink
Shielding:	Less than 0.1 mR/hour at 5cm away from surface of the unit when operated at 80kV, 500µA as per FDA 21 CFR 1020.40
Size:	10.5" L x 5.8" W x 4.0" H (266mm L x 146mm W x 101mm H)
Weight:	≤ 9 lbs.
Input Power:	22-26 VDC, 3A
Interface:	Analog (0-10VDC), RS422 & RS485
Safety & Regulatory Compliance:	Designed to meet UL, CE and RoHS Directive 2011/65/EU

Trinity 9100004 80kV, 33µm, 40 Watt integrated X-ray source



DIMENSIONS: Inches [mm]

The UltraBright Microfocus System 96000 Series is a 90kV, 80W X-ray source designed for applications where high brightness, high magnification and small spot size are important.

Operated by an external high voltage Smart Controller capable of providing variable voltage and power control, the UltraBright Microfocus System delivers exceptional magnification and image quality with full control of "Brightness". Maximum flux output is maintained through automatic matching of a given power setting to a corresponding optimal spot size.

Benefits

- Exceptional magnification and image quality
- High power operation — ideal for high flux applications and experiments.
- Integrated package eliminates HV cable for improved reliability
- Complete range of user control — ideal for research applications
- Compact, lightweight design — ideal for portable applications

Applications

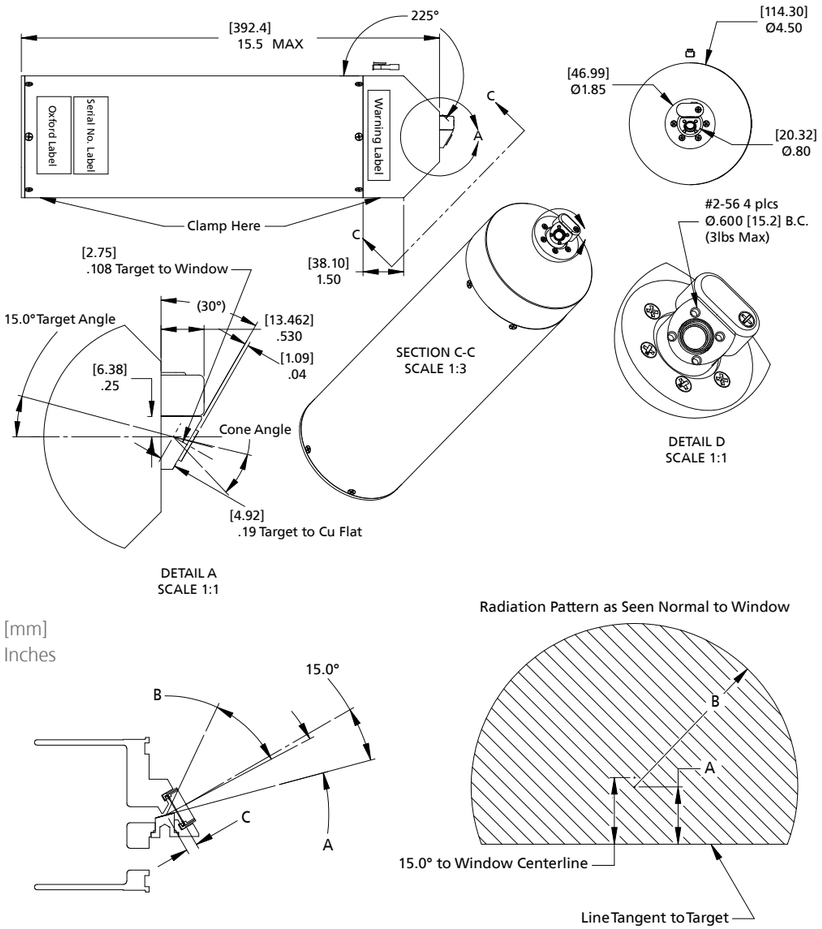
- Microtomography
- Microdiffraction
- Microfluorescence
- CT imaging for life sciences and industrial inspection

Product Ordering Table

Target Material (Part#)	Voltage	Power	Power Density
W (96004)	10-90kV	10-80W	2.5W/µm
Mo (96002)	20-60kV	20-60W	1.5 W/µm
Cu (96000)	20-60kV	20-60W	1.5 W/µm

Specifications	
Operating voltage range:	See product ordering table
Maximum Power:	See product ordering table
Maximum beam current:	2.0mA
Focal spot size:	14-20µm @ maximum voltage and minimum power
Focus to Object Distance (FOD):	4mm
Cone of illumination:	50° x 74° (nominal) See chart on next page
Window material and thickness:	Be, 245µm
Window diameter (unobstructed):	9.5mm (0.37")
Window configuration	End window
Target material:	See product ordering table
Ambient operating temperature:	10°C to 40°C
Maximum operating temperature (anode):	70°C
Cooling method:	Forced air (150 CFM @ 4" recommended for continuous operation)
Shielding:	Not shielded
Dimensions:	392.4mm L x Ø114.3mm (15.5" L x Ø4.5")
Weight:	≤ 4kg (8.81lbs.)
Storage conditions:	-10°C to 55°C Barometric Pressure: 50-106kPa; Humidity: 10-90% (no condensation) Condensation on Be window will cause window corrosion, vacuum loss and X-ray tube failure.

UltraBright 96000 Series 90kv Microfocus X-ray Source



DIMENSIONS: [mm]
Inches

Dimension	Description	Units	Emitted Cone and Spot Position		
			Farthest	Nominal	Nearest
A	Location of radiation cone center	Degrees	10.6	12.9	16.4
B	Radius of cone	Degrees	32.2	36.8	42
C	Window to spot distance	mm	4.47	3.14	1.82

RS232 Control Command Set

Protocol:	RS-232-C
Baud Rate:	9600 ASYNC
Flow control:	None
Data bits:	8
Stop bits:	1
Parity:	None
Connector:	Type: 25 pin

Functions

Anode voltage set:	10 to 90kV (example: VCN 50 = set 50kV)
Brightness set:	10 to 80W (example: WCN 40 = set 40W)
Command:	X-ray ON/OFF
Command:	Voltage min-max set

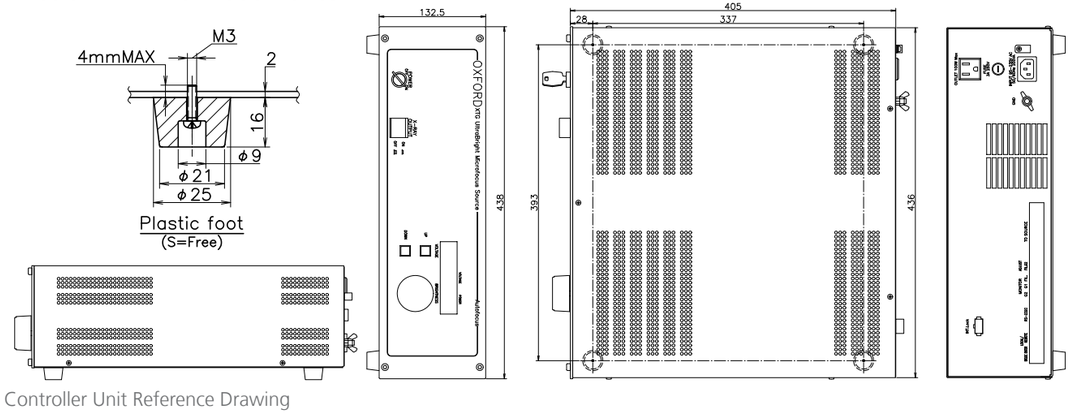
Read Back

Voltage:	(example: VM 30 = 30kV)
Brightness:	(example: WM 20 = 20W)
Status:	Stand-by, warm-up, output, fault modes in ASCII format
Fault:	Display panel information except remote/local mode will be in ASCII format
Other:	ROM version number

Controller Unit Specifications	
Functions:	Key switched power, HV on/off, kV adjust, brightness/autofocus adjust
External control:	Remote control
Power consumption:	100W maximum
Input voltage:	110/240 AC autosensing
Approximate weight:	4kg
HV cable:	Not necessary
LV cable:	Std 25 pin D-type connector (up to 25 feet)

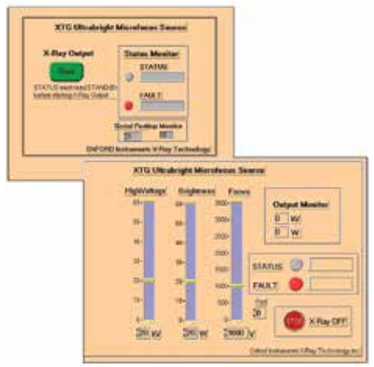
Item	RS232 Control	Manual Operation	Notes
Remote/local switch	No	Yes	Switch is located on rear panel
Power on/off	No	Yes	For remote operation, front panel on/off switch must be “On”
X-ray on/off:	Yes	Yes	For remote operation, front panel on/off switch must be “On”
Voltage up/down	Yes	No	Front panel switch disabled
Brightness control	Yes	No	Front panel switch disabled

Power on can be accomplished remotely by X-ray on/off command. However, if cathode emitter is turned off, power is restored only through front panel on/off switch. Safety interlocks available on real panel.



Controller Unit Reference Drawing
Dimensions in mm

Software Control Option



- Runs under LabVIEW RT & MS-Windows
- Works in conjunction with RS232 control interface
- Complete control of voltage, power, and focus
- Dynamic status display
- Dynamic fault display
- Ideal for R&D applications
- Open software architecture allows for modification with available additional development software

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Functions	Software Control	Manual Operation	Notes
Remote/Local switch	No	Yes	Switch is located on rear panel
Power On/Off	No	Yes	For software operation, front panel On/Off switch must be “On”
X-ray On/Off	Yes	Yes	For software operation, front panel On/Off switch must be “On”
Voltage up/down	Yes	No	Front panel switch disabled
Power adjust	Yes	No	Front panel Brightness dial disabled

Microfocus Source with the following Class-Leading Performance Characteristics:

- The UltraBright 96000 Series is a fully integrated 90kV X-ray source. Its high voltage power supply and controller provide variable control of high voltage from 10-90kV and beam current from .33-2 milliamps with full control of “Brightness”. The Smart Controller calculates spot size for a given power setting for maximum flux output.
- Voltage and current rating (90kV, 2.0mA) are subject to maximum power dissipation rating of 80W. The X-ray tube assembly is sealed, air-cooled, and rated for continuous operation.
- X-ray microfocus spot size is continuously adjustable from 14µm to 20µm. Power de-rating is provided at small spot sizes but source power is greater than or equal to 20W for a 20µm spot size.
- The anode target material is comprised of Tungsten as standard, however other targets are available (Cu, Mo). The target is inclined at a takeoff angle of 15 degrees with respect to the electron beam, and the exit window is aligned at an angle of 30 degrees with respect to the electron beam, so that a round microfocus X-ray spot is projected through the exit window.
- The stability of the microfocus X-ray spot shall be less than 5µm RMS over a period of 8 hours, as verified by test. A warm- up time of up to two hours is necessary in order to meet this specification.
- The system is supplied with a 254 micron Be exit window, allowing for close coupling (4mm) of object with the anode X-ray spot.
- LabVIEW RT Software Interface: The Smart Controller is outfitted with a software package that provides remote control of the various functions, such as kV, mA, Brightness, power etc. It includes an RS232 Communication package and an RT version of National Instruments LabVIEW. See Software control datasheet for complete description.

The Nova Microfocus System 96000 Series is a 90kV, 80W, water-cooled X-ray source designed for applications where high power, high magnification and small spot size are important.

Operated by an external high voltage Smart Controller capable of providing variable voltage and power control, the Nova Microfocus System delivers exceptional magnification and image quality with full control of "Brightness." Maximum flux output is maintained through automatic matching of a given power setting to a corresponding optimal spot size.

Benefits

- Exceptional magnification and image quality
- High power operation — ideal for high flux applications and experiments.
- Integrated package eliminates HV cable for improved reliability
- Complete range of user control — ideal for research applications
- Compact, lightweight design — ideal for portable applications

Applications

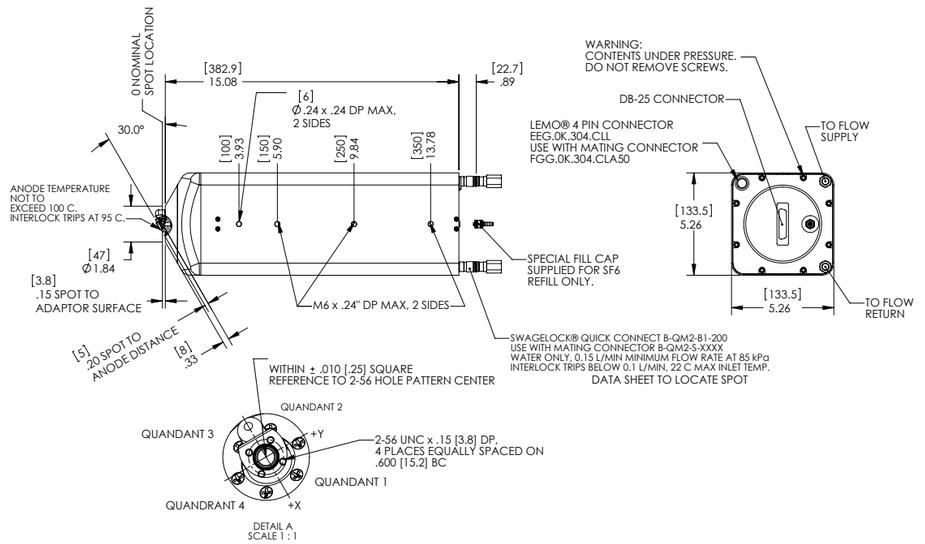
- Microtomography
- Microdiffraction
- Microfluorescence
- CT imaging for life sciences and industrial inspection

Product Ordering Table

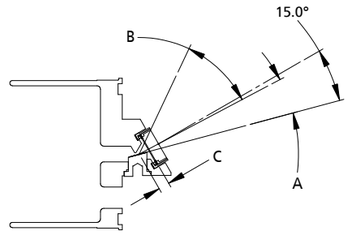
Target Material (Part#)	Voltage	Power	Power Density
W (96013)	10-90kV	10-80W	2.5W/µm
Mo (96016)	20-60kV	20-60W	1.5 W/µm

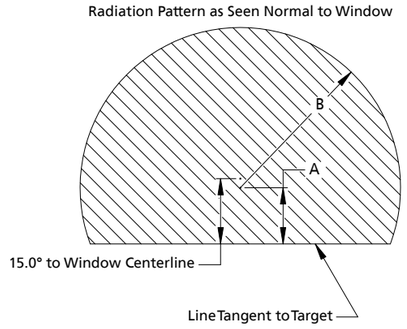
Specifications	
Operating voltage range:	See product ordering table
Maximum power:	See product ordering table
Maximum beam current:	2.0mA
Focal spot size:	14-20µm @ maximum voltage and minimum power
Focus to Object Distance (FOD):	4mm
Cone of illumination:	50° x 74° (nominal) See chart on next page
Window material and thickness:	Be, 245µm
Window diameter (unobstructed):	9.5mm (0.37")
Window configuration	End window
Target material:	See product ordering table
Ambient operating temperature:	10°C to 40°C
Maximum operating temperature (anode):	70°C
Cooling method:	H_2O 0.15 l/min @ 15 psi
Shielding:	Not shielded
Dimensions:	392.4mm L x 114.3mm W (15.5" L x 4.5" W)
Weight:	≤ 4kg (8.81 lbs)
Storage conditions:	-10°C to 55°C Barometric Pressure: 50-106kPa; Humidity: 10-90% (no condensation) Condensation on Be window will cause window corrosion, vacuum loss and X-ray tube failure

Nova 96000 Series 90kv Water-Cooled Microfocus X-ray Source


0 NOMINAL SPOT LOCATION
[382.9] 15.08
[22.7] .89
[6] Ø .24 x .24 DP MAX, 2 SIDES
30.0°
[100] 3.93
[150] 5.90
[250] 9.84
[350] 13.78
ANODE TEMPERATURE NOT TO EXCEED 100 C. INTERLOCK TRIPS AT 95 C.
[47] Ø 1.84
[3.8] .15 SPOT TO ADAPTOR SURFACE
[5] .20 SPOT TO ANODE DISTANCE
[8] .33
M6 x .24" DP MAX, 2 SIDES
SPECIAL FILL CAP SUPPLIED FOR SF6 REFILL ONLY.
WARNING: CONTENTS UNDER PRESSURE. DO NOT REMOVE SCREWS.
DB-25 CONNECTOR
LEMO® 4 PIN CONNECTOR EEG.0K.304.CLL USE WITH MATING CONNECTOR FGG.0K.304.CLA50
TO FLOW SUPPLY
[133.5] 5.26
[133.5] 5.26
TO FLOW RETURN
SWAGELOCK® QUICK CONNECT B-QM2-B1-200 USE WITH MATING CONNECTOR B-QM2-S-XXXX WATER ONLY, 0.15 L/MIN MINIMUM FLOW RATE AT 85 kPa INTERLOCK TRIPS BELOW 0.1 L/MIN, 22 C MAX INLET TEMP.
DATA SHEET TO LOCATE SPOT
WITHIN ± .010 [.25] SQUARE REFERENCE TO 2-56 HOLE PATTERN CENTER
QUANDANT 2
QUANDANT 3
+Y
2-56 UNC x .15 [3.8] DP, 4 PLACES EQUALLY SPACED ON .600 [15.2] BC
QUANDANT 1
QUANDANT 4
+X
DETAIL A
SCALE 1 : 1

DIMENSIONS: [mm]
Inches





			Emitted Cone and Spot Position		
Dimension	Description	Units	Farthest	Nominal	Nearest
A	Location of radiation cone center	Degrees	10.6	12.9	16.4
B	Radius of cone	Degrees	32.2	36.8	42
C	Window to spot distance	mm	4.47	3.14	1.82

RS232 Control Command Set

Protocol:	RS-232-C
Baud Rate:	9600 ASYNC
Flow control:	None
Data bits:	8
Stop bits:	1
Parity:	None
Connector:	Type: 25 pin

Functions

Anode voltage set:	10 to 90kV (example: VCN 50 = set 50kV)
Brightness set:	10 to 80W (example: WCN 40 = set 40W)
Command:	X-ray ON/OFF
Command:	Voltage min-max set
Command:	Brightness min-max set

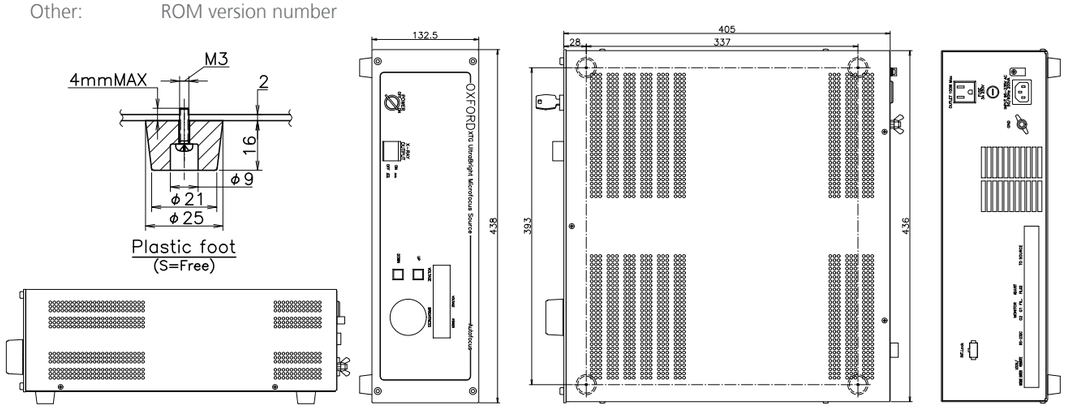
Read Back

Voltage:	(example: VM 30 = 30kV)
Brightness:	(example: WM 20 = 20W)
Status:	Stand-by, warm-up, output, fault modes in ASCII format
Fault:	Display panel information except remote/local mode will be in ASCII format
Other:	ROM version number

Controller Unit Specifications	
Functions:	Key switched power, HV on/off, kV adjust, brightness/autofocus adjust
External control:	Remote control
Power consumption:	100W maximum
Input voltage:	110/240 AC autosensing
Approximate weight:	4kg
HV cable:	Not necessary
LV cable:	Std 25 pin D-type connector (up to 25 feet)

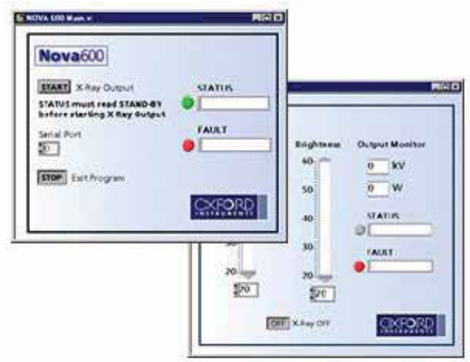
Item	RS232 Control	Manual Operation	Notes
Remote/local switch	No	Yes	Switch is located on rear panel
Power on/off	No	Yes	For remote operation, front panel on/off switch must be “On”
X-ray on/off:	Yes	Yes	For remote operation, front panel on/off switch must be “On”
Voltage up/down	Yes	No	Front panel switch disabled
Brightness control	Yes	No	Front panel switch disabled

Power on can be accomplished remotely by X-ray on/off command. However, if cathode emitter is turned off, power is restored only through front panel on/off switch. Safety interlocks available on real panel.



Controller Unit Reference Drawing
Dimensions in mm

Software Control Option



- Runs under LabVIEW RT & MS-Windows
- Works in conjunction with RS232 control interface
- Complete control of voltage, power, and focus
- Dynamic status display
- Dynamic fault display
- Ideal for R&D applications
- Open software architecture allows for modification to user interface with available additional development software

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Functions	Software Control	Manual Operation	Notes
Remote/Local switch	No	Yes	Switch is located on rear panel
Power On/Off	No	Yes	For software operation, front panel On/Off switch must be “On”
X-ray On/Off	Yes	Yes	For software operation, front panel On/Off switch must be “On”
Voltage up/down	Yes	No	Front panel switch disabled
Power adjust	Yes	No	Front panel Brightness dial disabled

Microfocus Source with the following Class-Leading Performance Characteristics:

- The Nova 96000 Series is a fully integrated 90kV X-ray source. Its high voltage power supply and controller provide variable control of high voltage from 10-90kV and beam current from .33-2 milliamps with full control of “Brightness”. The Smart Controller calculates spot size for a given power setting for maximum flux output.
- Voltage and current rating (90kV, 2.0mA) are subject to maximum power dissipation rating of 80W. The X-ray tube assembly is sealed, water-cooled, and rated for continuous operation.
- X-ray microfocus spot size is continuously adjustable from 14µm to 20µm. Power de-rating is provided at small spot sizes but source power is greater than or equal to 20W for a 20µm spot size.
- The anode target material is comprised of Tungsten as standard, however a molybdenum target is also available. The target is inclined at a takeoff angle of 15 degrees with respect to the electron beam, and the exit window is aligned at an angle of 30 degrees with respect to the electron beam, so that a round microfocus X-ray spot is projected through the exit window.
- The stability of the microfocus X-ray spot shall be less than 5µm RMS over a period of 8 hours, as verified by test. A warm-up time of up to two hours is necessary in order to meet this specification.
- The system is supplied with a 254 micron Be exit window, allowing for close coupling (4mm) of object with the anode X-ray spot.
- LabVIEW RT Software Interface: The Smart Controller is outfitted with a software package that provides remote control of the various functions, such as kV, mA, Brightness, power etc. It includes an RS232 Communication package and an RT version of National Instruments LabVIEW. See Software control datasheet for complete description.

Developed for applications that require high resolution over a wide-angle field of view, the Pinnacles 50kV Microfocus X-ray source features high flux output.

Its compact design is fully radiation shielded and insulated with an integrated high voltage cable located on the side of the tube for easy connection.

The Shasta µF power supply has been optimized to power the Pinnacles 50kV Microfocus X-ray tube.

Benefits

- Wide operating range enables optimal image contrast
- Wide field of view
- Fully shielded package eliminates X-ray leakage and easily integrates into your system
- Integrated high voltage cable

Applications

- Medical imaging
- Printed circuit board and electronic device inspection
- Nondestructive testing of plastic, metal and mechanical parts

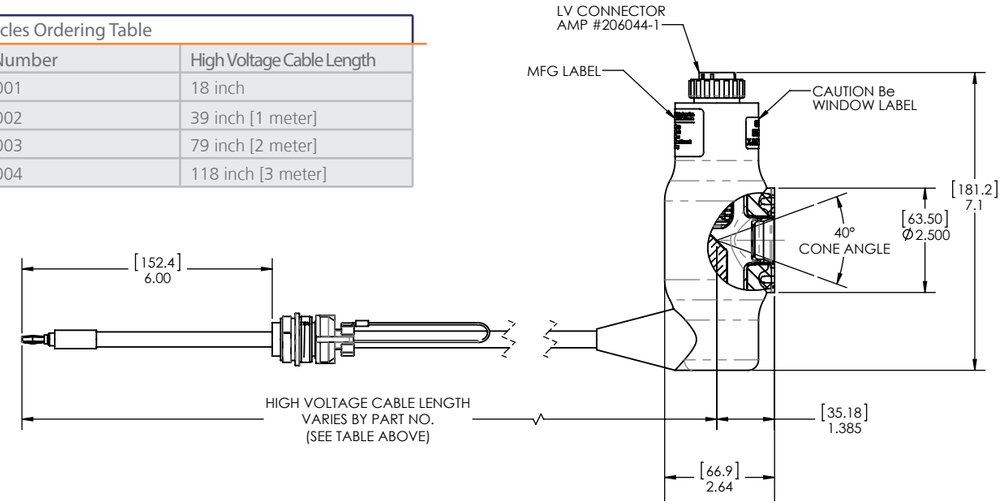
Specifications	
Operating voltage range:	10-50kV
Maximum power:	12W
Maximum beam current:	1.0mA
Focal spot size:	10µm (50kV, 3W) line pair resolution using JIMA RT RC-02
Focus to Object Distance (FOD):	21.8mm (0.858")
Cone of illumination (unobstructed):	40.5° ± 0.5°
Window material and thickness:	Be, 254µm
Window diameter (unobstructed):	16.88mm (.66")
Target material:	W
Maximum operating temperature:	50°C at potting surface
Ambient operating temperature:	0°C to 40°C; 0-95% RH up to 5,000ft
Cooling method:	Forced air @ 150cfm at 100mm (4.0") recommended
Shielding:	Fully shielded. X-ray leakage < 1.0µSv.hr-1 at 10cm
Weight:	≈1.37kg (3 lbs)
Storage conditions:	-10°C to 55°C Barometric Pressure: 50-106kPa; Humidity: 10-90% (no condensation) Condensation on Be window will cause window corrosion, vacuum loss and X-ray tube failure

Shasta µF Power Supply

- Industry-standard 24V Input
- High voltage, cathode, and grid controls
- Intuitive analog control interface
- Focusing grid adjustment for optimum spot size

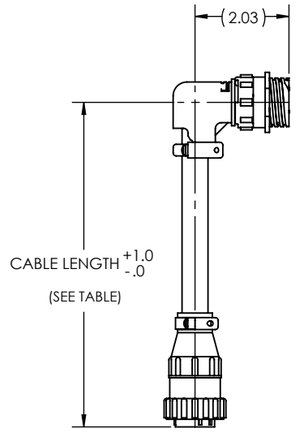
Pinnacles 50kV Microfocus X-ray Source

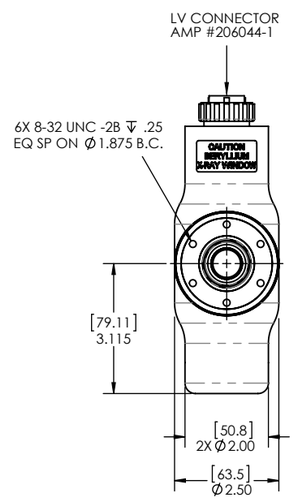
Pinnacles Ordering Table	
Part Number	High Voltage Cable Length
9400001	18 inch
9400002	39 inch [1 meter]
9400003	79 inch [2 meter]
9400004	118 inch [3 meter]



Low Voltage Cable Ordering Table	
Part Number	Cable Length
9290002	39 inch [1 meter]
9290003	79 inch [2 meter]
9290004	118 inch [3 meter]

LV Connector Pin	Tube Pin
3	GROUND
4	HEATER
5	HEATER GROUND
7	L1
12	L2
14	L3





Notes

1. THIS TUBE IS FULLY RADIATION SHIELDED TO 50kV/12W EXCEPT 40° X-RAY CONE.
2. DIMENSIONS ARE IN INCHES. DIMENSIONS [] ARE IN MILLIMETERS.

The Jupiter 5000 Series is a 50kV, 50 Watt packaged X-ray tube designed for applications where high flux density and continuous operation are important.

Utilizing our highly stable and high intensity X-ray tube technology, the Jupiter 5000 Series is ideal for medical imaging applications and most industrial inspection and non-destructive testing applications that require high resolution, including PCB assembly, battery, plastic, metal and mechanical parts inspection.

The 5000 Series features a stainless steel, lead-lined package that is filled with dielectric oil, which enables the unit to provide maximum X-ray shielding and heat dissipation. The design includes high voltage and filament connectors, making it ideal for plug and play operation.

The Jupiter 5000 Series is available in a wide range of spot sizes, targets and price points to meet your needs.

Benefits

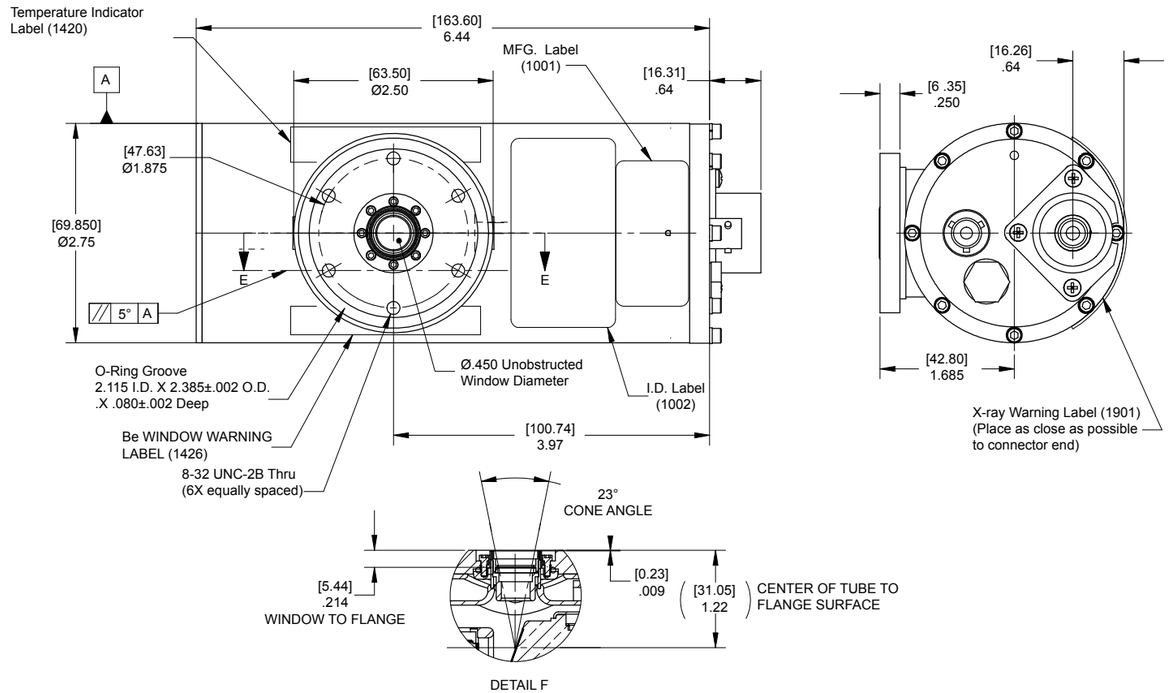
- Wide operating range enables optimal image contrast
- Stable X-ray output delivers high-precision measurements
- Low attenuation beryllium window ensures high transmission of low energy X-rays
- Fully shielded compact package eliminates X-ray leakage and easily integrates into your system

Applications

- Medical Imaging
- Printed circuit board and electronic device inspection
- Non-destructive testing of plastic, metal and mechanical parts
- Thickness gauging
- Analytical XRF

Specifications	
Operating Voltage Range:	10-50kV
Maximum Power:	50W
Maximum Beam Current:	1.0mA
Focal spot size:	P/N 93089: 50µm P/N 93095: 55µm
Maximum Filament Current:	1.7A
Filament Voltage:	2.0V (nominal)
Focus to Object Distance (FOD):	See diagram next page
Window material and thickness:	Be @ 127µm
Cone of illumination (unobstructed):	23°
Window diameter (unobstructed):	11.43mm (.450")
Target material:	See product ordering table next page
Target angle:	12°
Stability:	0.2% 4 hours
Polarity:	Grounded cathode
Maximum operating temperature:	55°C on case surface
Ambient operating temperature:	0°C to 40°C
Cooling method	Forced air @ 150cfm
Shielding:	0.25mR/hr @ 2" (except at HV connection)
Dimensions:	180mm L x Ø70mm (7.09" L x Ø2.76")
Weight:	1.82kg (4lbs)
Storage Conditions:	-10°C to 55°C Barometric Pressure: 50-106kPa; Humidity: 10-90% (no condensation) Condensation on Be window will cause window corrosion, vacuum loss and X-ray tube failure

Jupiter 5000 Series Radiation Shielded X-ray Tube



Notes

1. USE AN AS568A-139 O-RING IN MOUNTING PLATE GROOVE IF REQUIRED
2. DIMENSIONS ARE IN INCHES. DIMENSIONS [] ARE IN MM

Product Ordering Table		
Target Material	Voltage	Power
W (93089)	10-50kV	50W
Mo (93095)	10-50kV	50W

Use a Shasta Power Supply for Peak Performance

The Neptune 5200 Series is a water-cooled 50kV, 100 Watt packaged X-ray tube designed for applications where high flux density and continuous operation are important.

Utilizing our high stability and high intensity X-ray tube technology, the Neptune 5200 Series is ideal for most industrial inspection and non-destructive testing applications that require high resolution, including plastic, metal and mechanical parts inspection. Flexible and reliable, this unit is also highly suited for use in high power XRF applications.

The 5200 Series has a brass package that features 0.2 liter/min of water flow, which enables the unit to provide maximum X-ray shielding and heat dissipation. The design includes high voltage, filament and water flow connectors, making it ideal for plug and play operation.

The Neptune 5200 Series is available in wide range of targets and price points to meet your needs.

Benefits

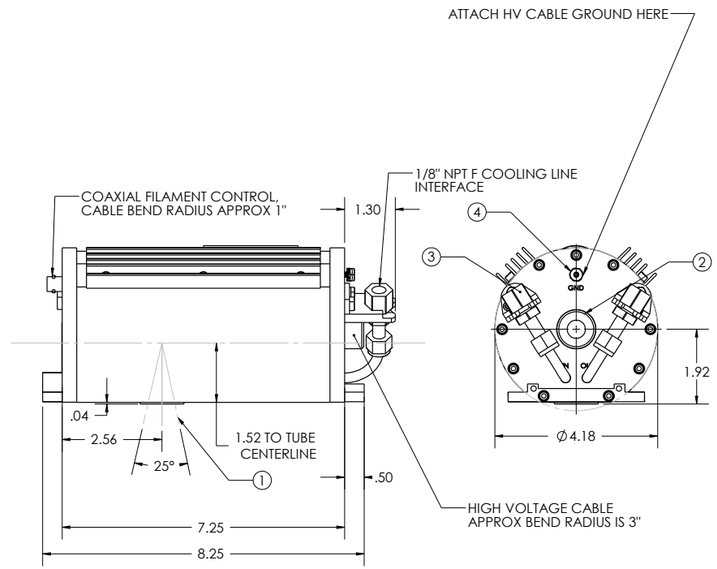
- Wide operating range enables optimal image contrast
- Stable X-ray output delivers high precision measurements
- Low attenuation beryllium window ensures high transmission of low energy x-rays
- Fully-shielded compact package eliminates X-ray leakage and easily integrates into your system

Applications

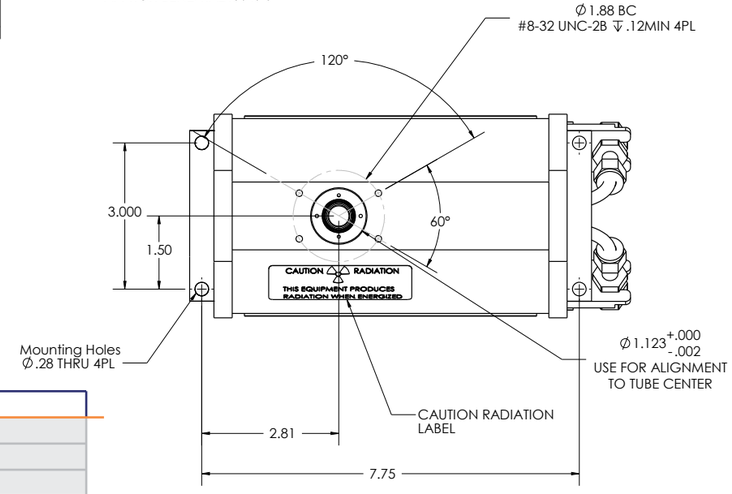
- Non-destructive testing of plastic, metal and mechanical parts
- Thickness gauging
- Analytical XRF

Specifications	
Operating Voltage Range:	10-50kV
Maximum Power:	100W
Maximum Beam Current:	2.0mA
Maximum Filament Current:	2.40A
Filament Voltage:	3.75V (Nominal)
Target Material:	See Product Ordering Table
Spot Size:	175µm where X+Y/2 and X < 210µm and Y < 210µm
Cone of Illumination:	25°
Spot to Window Spacing (FOD):	48.8 mm ± 1mm (1.92")
Window Material & Thickness:	Be @ 127µm
Flux & Current Stability:	≤ 0.2% over 4-hour period
Duty Cycle:	Continuous
Ambient Temperature Conditions:	Operating: 0 to 40°C Storage: -10°C to 50°C
Humidity:	0-95% RH up to 5,000ft
Method of Cooling:	Water cooling >.21 l/min. Forced air cooling directed at the unit at 150 CFM may be required at high power operation. Must not exceed 55°C at case surface.
Shielding:	0.25mR/hr @ 2" (except HV connection through HV cable)
Dimensions:	210mm L X 106 mm W (8.25" L X 4.18" W)
Weight:	6.17 kg (13.6 lbs)

Neptune 5200 Series Water-Cooled Radiation Shielded X-ray Tube



DIMENSIONS: Inches



Product Ordering Table	
Part Number	Target Material
93221	Rh
93211	Mo
93403	W

The Apogee 5500 Series is a 50kV, 50 Watt packaged X-ray tube designed for applications where high flux density and continuous operation are important.

Utilizing our high stability, high intensity X-ray tube technology coupled with grid-controlled variable focus enables our Apogee design to produce very small focal spots; this makes the Apogee 5500 Series ideal for most industrial inspection and non-destructive testing applications that require high resolution, including PCB assembly, battery, plastic, metal and mechanical parts inspection. Flexible and reliable, this unit is also well suited for use with X-ray optics.

The Apogee 5500 Series is configured in a compact stainless steel, lead-lined package filled with dielectric oil, which enables the unit to provide maximum X-ray shielding and heat dissipation. The design includes high voltage and filament connectors, making it ideal for plug and play operation.

Benefits

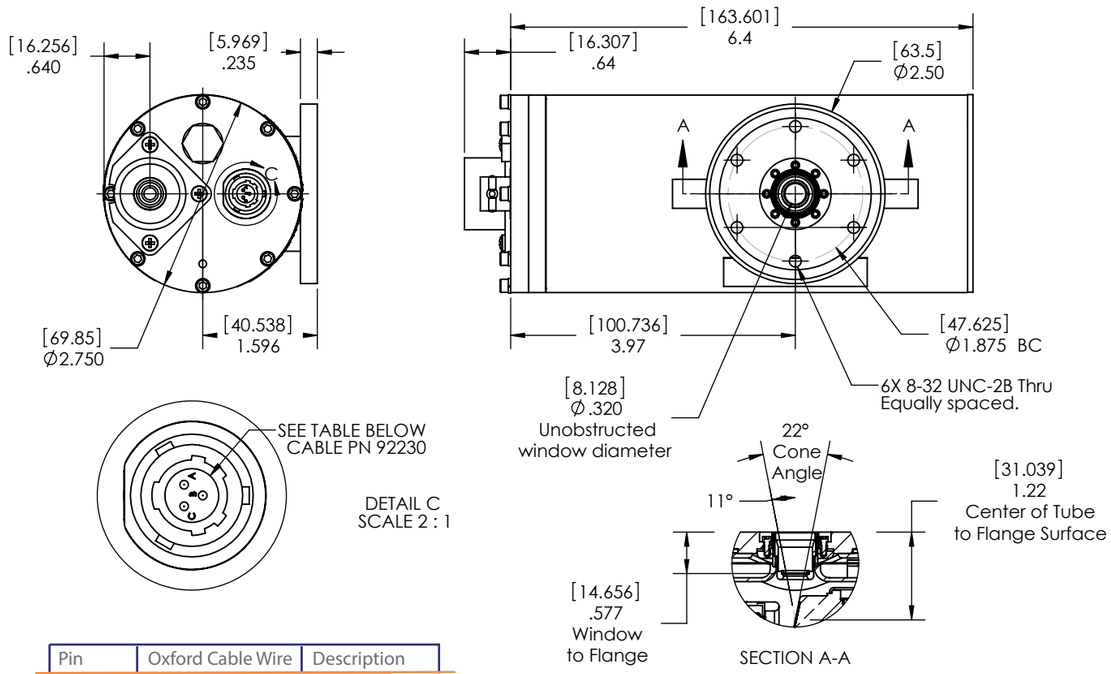
- Wide operating range enables optimal image contrast
- Stable X-ray output delivers high-precision measurements
- Low attenuation beryllium window ensures high transmission of low energy X-rays
- Fully shielded compact package eliminates X-ray leakage and easily integrates into your system

Applications

- Medical Imaging
- Inspection of printed circuit boards and electronic devices
- Non-destructive testing of plastic, metal and mechanical parts
- Thickness gauging
- Analytical XRF

Specifications	
Operating Voltage Range:	10-50kV
Maximum Power:	50W
Maximum Beam Current:	1.0mA
Grid Voltage:	0-100V (Oxford Shasta Power Supply recommended)
Maximum Filament Current:	1.7A
Filament Voltage:	2.0V (Nominal)
Target Material:	See product ordering table on next page
Focal Spot Size:	35µm *nominal per IEC60336, NEMA XR5-1992 (R1999)
Cone of Illumination:	22°
Spot to Window Spacing (FOD):	31.05mm ±1mm
Window Material and Thickness:	Be @ 127µm
Flux and Current Stability:	≤ 0.2% over 4-hour period
Duty Cycle:	Continuous (150 CFM airflow required)
Ambient Temperature Conditions:	Operating: 0 to 40°C Storage: -10°C to 50°C
Humidity:	0-95% RH up to 5,000 feet
Cooling Method:	External cooling required and directed at the unit at 150 CFM. Must not exceed 55°C at case surface.
Shielding:	0.25mR/hr @ 2" (except HV connection through HV cable)
Dimensions:	180mm L X Ø70mm (7.09" L X Ø2.76")
Weight:	1.82kg (4.0 lbs)

Apogee 5500 Series Radiation Shielded X-ray Tube



DIMENSIONS: [mm]
Inches

Pin	Oxford Cable Wire	Description
A	Red	Filament
B	Black	Filament Return
C	Clear	Grid Bias
Backshell	Eyelet	Ground

Product Ordering Table	
Part Number	Target Material
93501	W
93502	Mo
93504	Rh
93510	Cu

Use a Shasta Power Supply for Peak Performance

The Oxford Instruments 3000 Series X-ray tube has been developed for high flux stability and long life, making it ideal for continuous operation.

A low cost answer for high spectral purity radiation, the 3000 Series is encapsulated in silicone rubber and features a grounded cathode and low attenuation Beryllium window.

Features	Benefits
Continuous operation: 9W	High sensitivity and high precision measurement
Beryllium window	Higher flux of low-energy X-rays, especially from target L series lines
Compact, insulated light-weight package	Configuration allows flexible installation

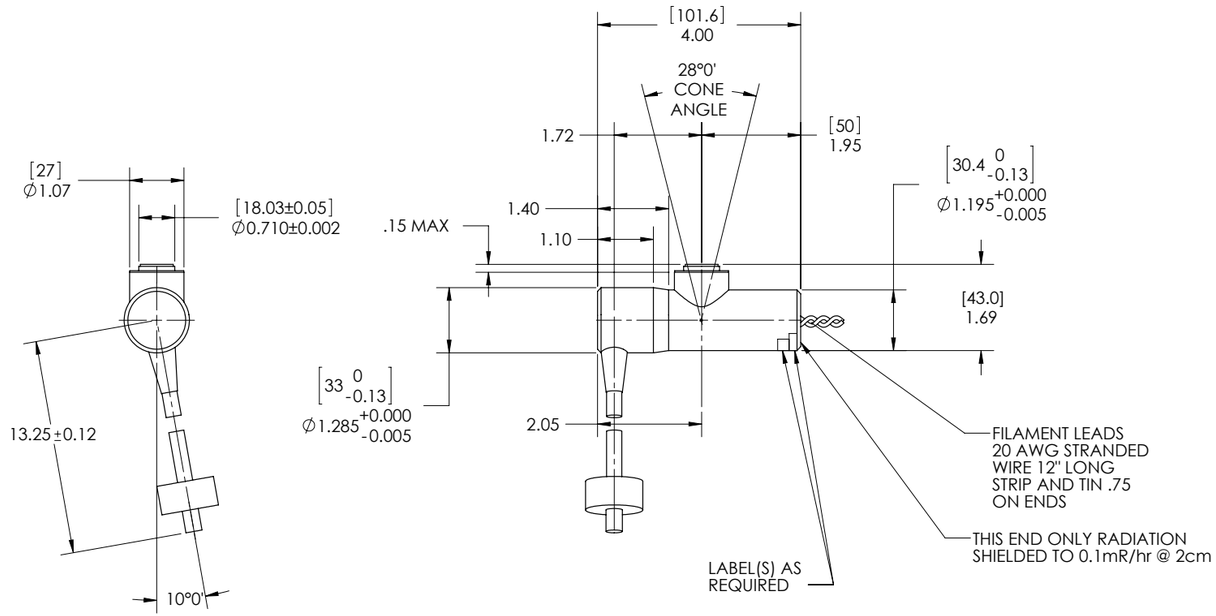
Applications

- Analytical (XRF)
- Particle Analysis
- Thickness Gauging
- Soft X-ray Radiography
- Spectroscopy
- Stress Analysis

Ordering Information	
Part Number	Target Material
90151	Rh
90152	Ag
90153	Mo

Specifications	
Operating Voltage Range:	4-30kV
Maximum power:	9W
Maximum beam current:	0.3mA
Maximum filament current:	2.0A
Filament voltage:	1.75V (nominal)
Focal spot size:	1.0mm (nominal)
Focus to Object Distance (FOD):	28.2mm (1.1")
Target material:	See ordering table above
Window material and thickness:	Be @ 125µm
Unobstructed cone of illumination:	28°
Unobstructed window diameter:	10.4mm (.41")
Target angle:	20°
Shielding:	Partially radiation shielded (see drawing next page)
Weight:	260g
Cooling method:	Forced air: 150CFM @ 100mm (4.0") and appropriate heat sink recommended for full power
Maximum operating temp:	50°C at potting surface
Ambient operating temp:	0°C to 40°C
Storage conditions:	-40°C to 70°C*
	*Note: Barometric Pressure: 50-106kPa Humidity: 10-90% (no condensation) Condensation on Be window will cause window corrosion, vacuum loss, and X-ray tube failure

3000 Series 30kV X-ray Tube



Notes

1. WARNING: THIS TUBE IS NOT RADIATION SHIELDED.
2. DIMENSIONS ARE IN INCHES. DIMENSIONS [] ARE IN MM.

Oxford Instruments glass X-ray tubes are recognized for their performance and long life.

High flux and spot size stability make our X-ray tubes an ideal solution for demanding applications, such as those requiring continuous operation. The 90507 is uniquely designed with a very small isostatically focused spot for high resolution applications, such as mini C-Arm fluoroscopy. The robust electron gun assembly has been constructed for optimal use in integrated X-ray sources, where heat dissipation is an issue. Long tube life is achieved by ultra-high vacuum maintained with the Oxford Instruments unique Pin Flash getter. This tube operates in bi-polar mode.

Benefits

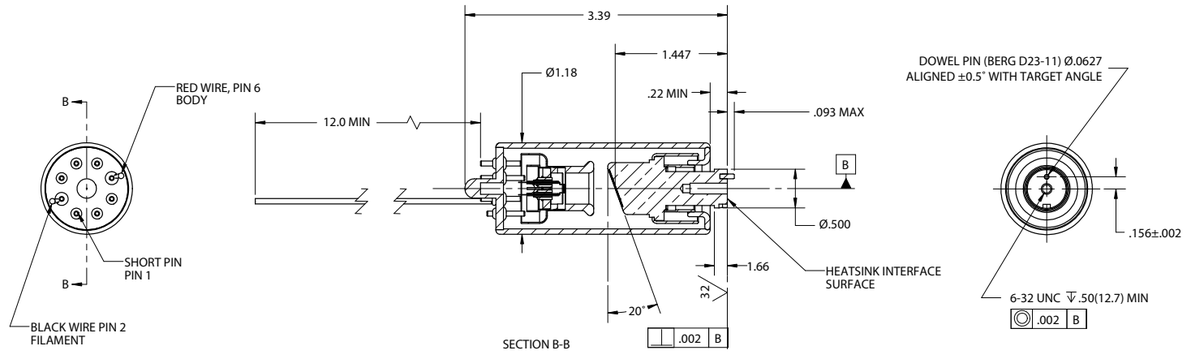
- Exceptional image quality
- Stable X-ray output delivers high precision measurements
- Small, stable spot delivers distortion-free measurements
- RoHS compliant design

Applications

- CT imaging for life sciences and industrial inspection
- Densitometry
- Thickness gauging
- Phase contrast imaging
- Medical imaging

Specifications	
Operating voltage range:	40-80kV (bi-polar operation: -40kV cathode, +40kV anode)
Maximum Power:	40W continuous
Maximum beam current:	0.5mA
Focal spot size:	33µm *nominal per IEC60336, NEMA XR5-1992 (R1999)
Maximum filament current:	1.7A
Filament voltage:	2.0V (nominal)
Focus to Object Distance (FOD):	14.2mm (0.56") (nominal)
Window material and thickness:	Glass—1.40mm ± 0.15
Target material:	W
Target angle:	20°
Maximum oil temperature:	80°C
Cooling method:	Oil
Weight:	114g (0.25lbs)
Storage conditions:	-10°C to 55°C Barometric Pressure: 50-106kPa; Humidity: 10-90% (no condensation)

1000 Series - 90507 Glass X-ray Tube



Notes

1. Dimensions are in inches.
2. This X-ray tube is designed to operate in an oil filled high voltage enclosure. Do not allow the oil to exceed 80˚C. Proper operation of the X-ray tube requires cooling oil to circulate freely around the X-ray tube envelope.
3. This X-ray tube produces X-rays in all directions. As such, it must only be operated in a radiation-shielded enclosure.
4. Tubes to be shipped with two telfon-coated copper wire leads, 1 8 AWG X 12.0 MIN, soldered to pins #6 and #2.

The 1500 Series X-ray tube is a 50kV, 50 Watt X-ray tube designed for applications where high flux density and continuous operation are important.

Utilizing our highly stable and high intensity X-ray tube technology, the 1500 Series X-ray tube is ideal for medical imaging, XRF applications and most industrial inspection and non-destructive testing applications that require high resolution, including PCB assembly, battery, plastic, metal and mechanical parts inspection.

The 1500 Series X-ray tube can also be supplied in a stainless steel, lead-lined package that is filled with dielectric oil that enables the unit to provide maximum X-ray shielding and heat dissipation, effectively replicating our popular Jupiter 5000 Series packaged tube, which includes high voltage and filament connectors making it ideal for plug and play operation.

The 1500 Series X-ray tube is available in a wide range of spot sizes, targets and price points to meet your needs.

Benefits

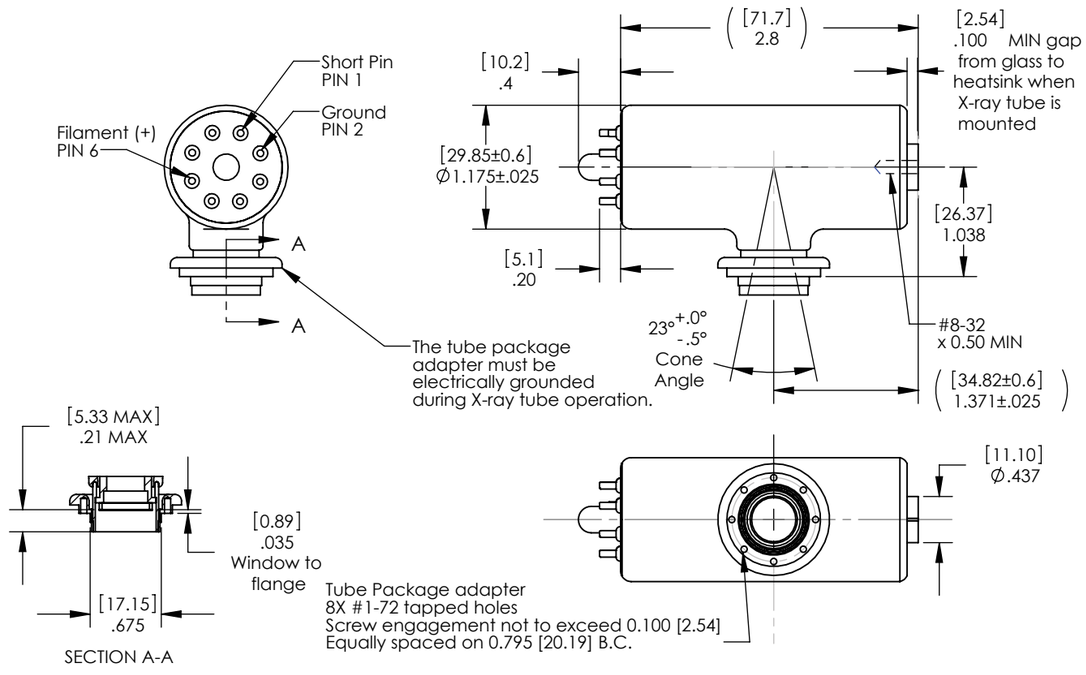
- Wide operating range enables optimal image contrast
- Stable X-ray output delivers high precision measurements
- Low attenuation beryllium window ensures high transmission of low energy X-rays

Applications

- Medical imaging
- Inspection of printed circuit boards and electronic devices
- Nondestructive testing of plastic, metal and mechanical parts
- Thickness gauging
- Analytical XRF

Specifications	
Operating Voltage Range:	10-50kV
Maximum Power:	50W
Maximum Beam Current:	1.0mA
Maximum Filament Current:	1.70A
Filament Voltage:	2.0V (Nominal)
Target Material:	All
Spot Size:	50-150µm (nominal per IEC60336,NEMA XR5-1999)
Cone of Illumination:	23°
Spot to Window Spacing (FOD):	30.8 mm ± 1mm (1.2")
Window Material and Thickness:	Be @ 127µm
Flux & Current Stability:	≤ 0.2% over 4-hour period
Duty Cycle:	Continuous
Ambient Temperature Conditions:	Operating: 0°C to 40°C Storage: -10°C to 50°C
Humidity:	0-95% RH up to 5,000ft
Method of Cooling:	Must not exceed 80°C oil temperature. Customer provides enclosure and cooling.
X-ray Shielding:	Customer must provide enclosure with adequate shielding. Tube emits X-rays in all directions.
Dimensions:	81mm L X 47mm W (3.2" L X 1.8" W)
Weight:	119g

1500 Series Glass X-ray Tube



DIMENSIONS: [mm]
Inches

Use a Shasta Power Supply for Peak Performance

The 1501 Series X-ray tube is a 50kV, 50-75 Watt X-ray tube designed for applications where high current, high flux density and continuous operation are important.

Utilizing our highly stable and high intensity X-ray tube technology, the 1501 Series X-ray tube is ideal for medical imaging, XRF applications and most industrial inspection and non-destructive testing applications that require high resolution, including PCB assembly, battery, plastic, metal and mechanical parts inspection.

The 1501 Series X-ray tube can also be supplied in a stainless steel, lead-lined package that is filled with dielectric oil that enables the unit to provide maximum X-ray shielding and heat dissipation.

The 1501 Series was designed in response to the need for higher current coupled with lower operating potentials.

The 1501 Series X-ray tube is available in a wide range of spot sizes, targets and price points to meet your needs.

Benefits

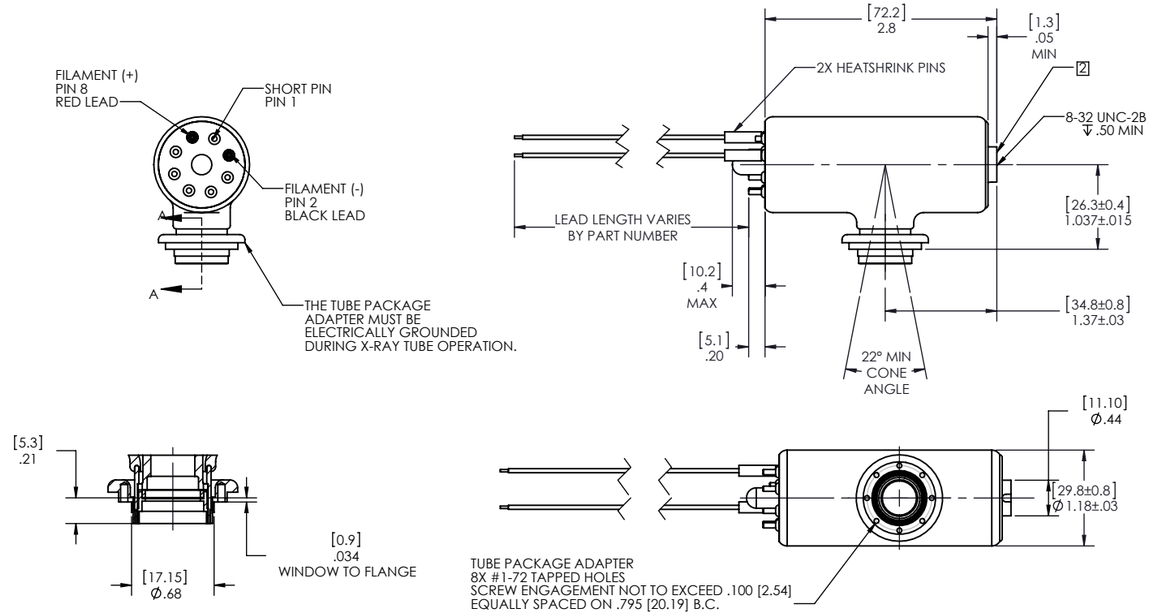
- Wide operating range enables optimal image contrast
- Stable X-ray output delivers high precision measurements
- Low attenuation beryllium window ensures high transmission of low energy X-rays

Applications

- Medical imaging
- Inspection of printed circuit boards and electronic devices
- Nondestructive testing of plastic, metal and mechanical parts
- Thickness gauging
- Analytical XRF

Specifications	
Operating Voltage Range:	4-50kV
Maximum Power:	50-75W
Maximum Beam Current:	2.5mA
Maximum Filament Current:	2.4A
Filament Voltage:	3.75V (Nominal)
Target Material:	All
Spot Size:	125µm (nominal per IEC60336,NEMA XR5-1999)
Cone of Illumination:	22° Minimum
Spot to Window Spacing (FOD):	30.8 mm ± 1mm (1.2")
Window Material and Thickness:	Be @ 127µm
Flux & Current Stability:	≤ 0.2% over 4-hour period
Duty Cycle:	Continuous
Ambient Temperature Conditions:	Operating: 0°C to 40°C Storage: -10°C to 50°C
Humidity:	0-95% RH up to 5,000ft
Method of Cooling:	Must not exceed 80°C oil temperature. Customer provides enclosure and cooling.
X-ray Shielding:	Customer must provide enclosure with adequate shielding. Tube emits X-rays in all directions.
Dimensions:	81mm L X 47mm W (3.2" L X 1.8" W)
Weight:	119g

1501 Series Glass X-ray Tube



DIMENSIONS: [mm]
Inches

The 1550 Series X-ray tube is a 50kV, 50 Watt X-ray tube designed for applications where high flux density and continuous operation are important.

Utilizing our highly stable, high intensity X-ray tube technology coupled with grid-controlled variable focus enables our 1550 Series X-ray tube to produce very small focal spots; this makes the 1550 Series ideal for most industrial inspection and non-destructive testing applications that require high resolution, including PCB assembly, battery, plastic, metal and mechanical parts inspection. Flexible and reliable, this unit is also highly suited for use with X-ray optics.

The 1550 Series X-ray tube can also be supplied in a stainless steel, lead-lined package that is filled with dielectric oil that enables the unit to provide maximum X-ray shielding and heat dissipation; this configuration is our popular Apogee 5500 Series packaged tube, which includes high voltage and filament connectors making it ideal for plug and play operation.

Benefits

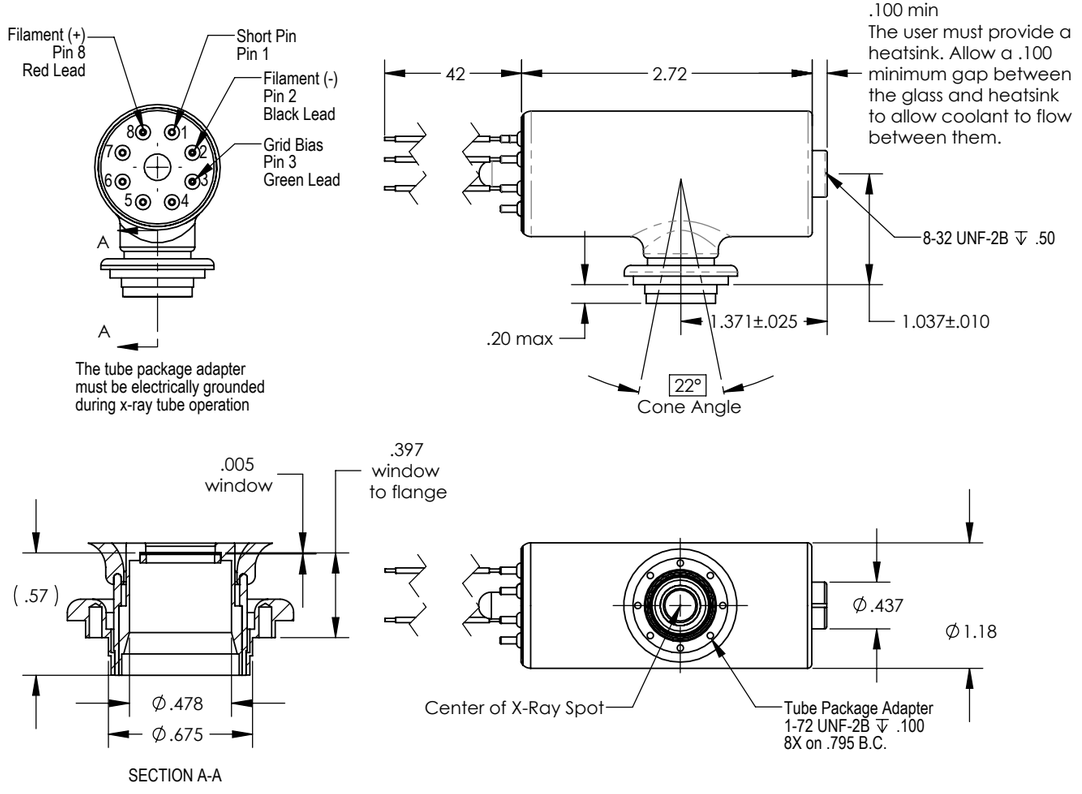
- Wide operating range enables optimal image contrast
- Stable X-ray output delivers high precision measurements
- Low attenuation beryllium window ensures high transmission of low energy X-rays

Applications

- Medical imaging
- Inspection of printed circuit boards and electronic devices
- Nondestructive testing of plastic, metal and mechanical parts
- Thickness gauging
- Analytical XRF

Specifications	
Operating Voltage Range:	10-50kV
Maximum Power:	50W
Maximum Beam Current:	1.0mA
Grid Voltage:	0-100V
Maximum Filament Current:	1.70A
Filament Voltage:	2.0V (Nominal)
Target Material:	All
Spot Size:	<50µm (X and Y)
Cone of Illumination:	22°
Spot to Window Spacing (FOD):	30.8 mm ± 1mm (1.213")
Window Material and Thickness:	Be @ 127µm
Flux & Current Stability:	≤ 0.2% over 4-hour period
Duty Cycle:	Continuous
Ambient Temperature Conditions:	Operating: 0°C to 40°C Storage: -10°C to 50°C
Humidity:	0-95% RH up to 5,000ft
Method of Cooling:	Must not exceed 80°C oil temperature. Customer provides enclosure and cooling.
X-ray Shielding:	Customer must provide enclosure with adequate shielding. Tube emits X-rays in all directions.
Dimensions:	81mm L X 47mm W (3.2" L X 1.8" W)
Weight:	119g

1550 Series Glass X-ray Tube



DIMENSIONS: Inches

Use a Shasta Power Supply for Peak Performance

Oxford Instruments Shasta series power supply features a robust design that has been optimized to power grounded filament X-ray tubes from Oxford Instruments, yet its versatility enables it to power virtually any grounded filament X-ray tube.

Utilizing closed loop emission control circuitry that delivers low ripple, Shasta provides highly regulated beam current and high stability resulting in superior performance. Local and remote analog control enables convenient operation in setting voltage & emission current.

- Models with grid focus control are designed to provide optimal performance with our Apogee tubes

Benefits

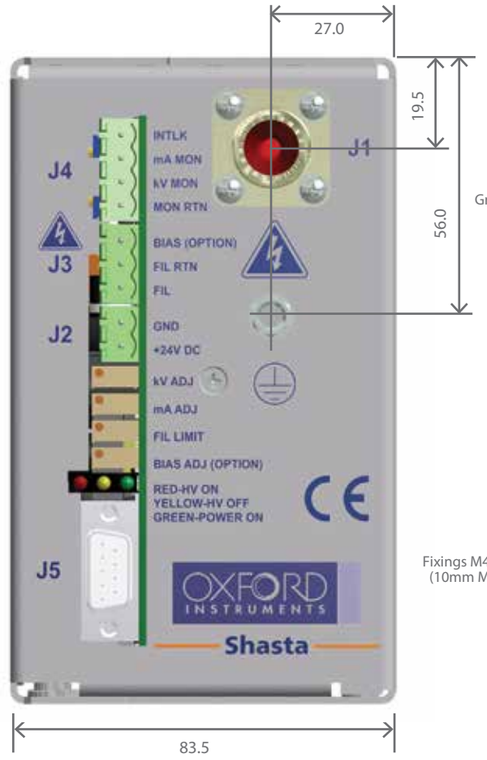
- Compact Design
- Adjustable Emission Current
- Voltage & Current Programming
- Optional Digital Interface
- Safety Interlock
- Optional Grid Focus Control
- UL, CE & TUV Certified

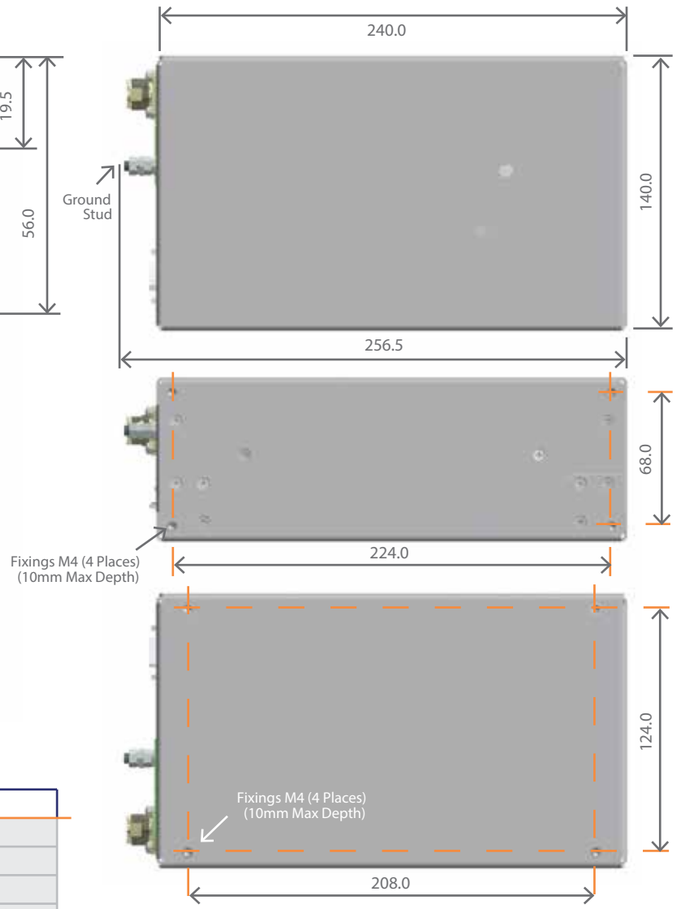
Applications

- XRF, XRD, Medical Imaging, Industrial Inspection & NDT

Specifications	
Operating voltage range:	0-50kV or 0-60kV models (see product ordering table next page)
Maximum Power:	50W or 60W models (see product ordering table next page)
Maximum beam current:	1.0mA
DC Filament Supply:	Current: 0.3 to 3.5A Voltage: 0 to 5.0 VDC
Voltage Regulation:	Load: < 0.01 % for 50% of max load variation Line: < 0.01% for 10% change in input voltage
Current Regulation:	Load: < ± 2µA (Beam Current) Line: < ± 2µA (Beam Current)
Ripple:	< 100V peak to peak
Stability:	± 0.1% over an 8-hour period after 30-minutes warm-up
Input Voltage & Power:	24VDC, ± 10%; 100 Watts
Voltage Control:	Local: via multi-turn potentiometer (kV ADJ) Remote: via external voltage source 0 to 10V (accuracy ± 1%)
Interlock:	Short to GND through a 12V lamp: HV/ON, OPEN:HV/OFF
Protection:	Over voltage, over current protection. Arc, short circuit.
Temperature Conditions:	Operational: 0 to 45˚C Storage: -20 to + 85˚C
Temperature Coefficient:	0.01 % per ˚C, voltage and current
Dimensions:	5.5" H x 3.3" W x 9.45" D (140mm x 83.5mm x 240mm)
Weight:	7.9 lbs. (3.6kg)
Regulatory & Safety:	Meets the requirements of IEC61010-1:2010, EN61010-1: 2010, UL61010-1: 2012, CA N/CSA C22.2 No. 61010- 1:2012 and 2006/95/EC Low Voltage Directive. Product carries the TUV SUD c/us mark.

Shasta 50kV & 60kV Power Supplies





Pin Assignments

J1	HV	OUTPUT	**J5**	1	+10VDC
J2	1	+24VDC		2	N.C.
	2	GND		3	kV Prog Input
J3	1	FILAMENT		4	RMT/LCL kV Prog Selector
	2	FILAMENT RETURN (GND)		5	N.C.
	3	BIAS		6	mA Prog Input
J4	1	MONITOR RETURN (GND)		7	RMT/LCL mA Prog Selector
	2	kV MONITOR		8	N.C.
	3	mA MONITOR		9	GND
	4	INTLK			

Product Ordering Table

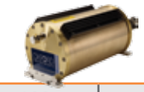
Part Number	Voltage	Power	Grid Control
9700001	50kV	50W	N/A
9700002	50kV	50W	0 to -300V
9700003	60kV	60W	N/A
9700004	60kV	60W	0 to -300V

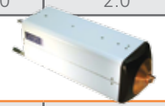
Part Number	Outline Drawing	Target	Operating Range (kV)	Max Anode Current (mA)	Max Anode Power (W)	Max Filament Current (A)	Spot Size (µm)*
1000 Series Glass X-ray Tubes							
See data sheet on page 26							
90501	8218	W	10 - 80	0.7	56	1.7	100 Max.
90502	8218	W	10 - 65	0.5	32.5	1.7	90 Max.
90503	8218	W	10 - 65	0.5	32.5	1.7	33 Nom.
90505	8225	W	10 - 50	1.0	50	1.7	200 Max.
90507	8218	W	10 - 80	0.7	40	1.7	33 Nom.
90512	8218	W	10 - 80	0.7	40	1.7	33 Nom.
1500 Series Glass X-ray Tubes with Window							
See data sheet on page 28							
90011	8194	Rh	10 - 50	1.0	50	1.7	150 Max.
90030	8260	Mo	10 - 50	1.0	50	1.7	150 Max.
90034	8188	Cr	10 - 50	1.0	50	1.7	200 Typ.
90054	8205	W	10 - 50	1.0	50	1.7	150 Typ.
90066	8205	Mo	10 - 50	1.0	50	1.7	150 Typ.
90068	8188	Mo	10 - 50	1.0	50	1.7	150 Typ.
90069	8188	Cu	10 - 50	1.0	50	1.7	150 Typ.
90075	8214	Cu	10 - 30	1.0	50	1.7	150 Typ.
90077	8188	Rh	10 - 50	1.0	50	1.7	150 Typ.
90078	8205	Cr	10 - 50	1.0	50	1.7	200 Typ.
90083	8188	W	10 - 50	1.0	50	1.7	150 Typ.
90099	8189	W	10 - 50	1.0	50	1.7	70 Max.
90101	8205	Rh	10 - 50	1.0	50	1.7	150 Typ.
90112	8061	Mo	10 - 50	1.0	50	1.7	150 Typ.
90127	8268	Mo	10 - 50	1.5	75	1.7	150 Max.
90128	8268	W	10 - 50	1.5	75	1.7	150 Max.
90133	8260	Rh	10 - 50	1.0	50	1.7	150 Max.
90135	8188	Ag	10 - 50	0.5	25	1.7	150 Typ.
90140	8189	Cr	10 - 50	1.0	15	1.7	70 Max.
90169	8069	W	10 - 50	1.0	50	1.7	70 Max.
1501 Series Glass X-ray Tubes with Higher Current							
See data sheet on page 30							
90015	8194	Rh	4 - 50	2.5	50	2.4	200 Max.
90122	8257	Cr	4 - 50	2.0	75	2.4	175 Max.
90131	8055	Rh	4 - 50	2.5	50	2.4	130 Max.
90132	8055	Mo	4 - 50	2.5	50	2.4	130 Max.

Part Number	Outline Drawing	Target	Operating Range (kV)	Max Anode Current (mA)	Max Anode Power (W)	Max Filament Current (A)	Spot Size (µm)*
1550 Series Glass X-ray Tubes with Grid Control							
See data sheet on page 32							
90200	8242	Cu	10 - 50	1.0	50	1.7	50 Max.
90201	8242	W	10 - 50	1.0	50	1.7	50 Max.
90202	8242	Mo	10 - 50	1.0	50	1.7	50 Max.
90203	8242	Co	10 - 50	1.0	10	1.7	50 Max.
90204	8242	Rh	10 - 50	1.0	50	1.7	50 Max.
90512	8218	W	10 - 80	0.7	56	1.7	33 Nom.
3000 Series Potted X-ray Tubes							
See data sheet on page 24							
90004	8145	W	4 - 30	0.5	15	1.3	1000 Typ.
90006	8053	W	4 - 30	0.2	6	1.3	1000 Typ.
90020	8052	Ti	4 - 30	0.5	15	1.3	1000 Typ.
90025	8052	W	4 - 10	1.0	10	1.3	1000 Typ.
90026	8263	Pd	4 - 30	0.1	2.5	1.3	1000 Typ.
90036	8053	W	4 - 30	0.3	9	1.3	1000 Typ.
90042	8195	Mo	4 - 30	0.5	15	1.3	1000 Typ.
90050	8053	W	4 - 30	0.2	6	1.3	1000 Typ.
90053	8204	Mo	4 - 15	1.0	15	1.3	1000 Typ.
90056	8263	Ti	4 - 25	0.1	2.5	1.3	1000 Typ.
90057	8156	Au	4 - 30	0.5	15	1.3	1000 Typ.
90072	8211	Cu	10 - 25	0.4	10	1.7	1000 Typ.
90116	8053	W	4 - 30	0.2	6	1.3	1000 Typ.
90118	8052	Fe	4 - 10	1.5	15	1.3	1000 Typ.
90124	8263	W	4 - 30	0.1	2.5	1.3	1000 Typ.
90125	8195	W	4 - 40	0.5	15	1.3	1000 Typ.
90136	8195	Cu	4 - 30	0.5	12	1.3	1000 Typ.
90141	8054	Rh	4 - 40	0.3	9	2.0	1000 Typ.
90142	8054	Ag	5 - 40	0.3	9	2.0	1000 Typ.
90143	8054	Mo	4 - 30	0.3	9	2.0	1000 Typ.
90144	8214	Cr	4 - 7.5	0.2	1.5	1.3	1000 Typ.
90145	8054	Pd	4 - 40	0.3	9	2.0	1000 Typ.
90146	8057	W	5 - 13.6	2.0	27.2	2.0	1000 Typ.
90151	8063	Rh	4 - 30	0.3	9	2.0	1000 Typ.
90152	8063	Ag	4 - 30	0.3	9	2.0	1000 Typ.
90153	8063	Mo	4 - 30	0.3	9	2.0	1000 Typ.

Appendix
February 2015

Part Number	Outline Drawing	Target	Operating Range (kV)	Max Anode Current (mA)	Max Anode Power (W)	Max Filament Current (A)	Spot Size (µm)*
Jupiter 5000 Series Radiation Shielded X-ray Tubes See data sheet on page 18							
93000	8166	W	10 - 50	1.0	50	1.7	165 Max.
93001	8166	Mo	10 - 50	1.0	50	1.7	150 Typ.
93009	8166	Rh	10 - 50	1.0	50	1.7	150 Typ.
93034	8144	W	10 - 50	1.0	50	1.7	150 Typ.
93043	8248	W	10 - 50	1.0	50	1.7	150 Typ.
93048	8166	Cu	10 - 50	1.0	50	1.7	150 Typ.
93055	8166	Mo	10 - 50	1.0	50	1.7	150 Typ.
93057	8166	Rh	10 - 50	1.0	50	1.7	180 Typ.
93059	8203	Rh	10 - 50	1.0	50	1.7	180 Typ.
93069	8166	W	10 - 50	1.0	50	1.7	70 Max.
93070	8166	Cr	10 - 50	1.0	50	1.7	200 Typ.
93073	8166	Pd	10 - 50	1.0	50	1.7	200 Max.
93075	8166	Rh	10 - 50	1.0	50	1.7	150 Max.
93078	8203	Cu	10 - 50	1.0	50	1.7	175 Max.
93079	8203	Mo	10 - 50	1.0	50	1.7	150 Typ.
93083	8166	W	10 - 50	1.0	50	1.7	70 Max.
93085	8166	W	10 - 50	1.0	50	1.7	150 Typ.
93087	8203	Rh	10 - 50	1.0	50	1.7	165 Max.
93089	8166	W	10 - 50	1.0	50	1.7	50 Max.
93091	8166	W	10 - 50	1.0	50	1.7	165 Max.
93093	8167	W	10 - 50	1.0	50	1.7	70 Max.
93095	8166	Mo	20 - 50	1.0	50	1.7	55 Max.
93111	8232	W	10 - 50	1.5	75	1.7	150 Typ.
93115	8232	Cu	10 - 50	2.5	50	2.5	150 Typ.
93119	8252	Mo	10 - 50	1.5	75	1.7	150 Max.
93200	8235	Mo	10 - 50	1.0	50	1.7	150 Max.
93201	8235	W	10 - 50	1.0	50	1.7	175 Max.
93202	8235	Cr	10 - 50	1.0	50	1.7	175 Typ.
93203	8235	Mo	10 - 50	1.0	50	1.7	150 Max.
93208	8235	W	10 - 50	1.0	50	1.7	150 Max.
93303	8231	W	10 - 50	1.5	75	1.7	150 Typ.
93401	8166	W	10 - 50	1.0	50	1.7	150 Typ.

Part Number	Outline Drawing	Target	Operating Range (kV)	Max Anode Current (mA)	Max Anode Power (W)	Max Filament Current (A)	Spot Size (µm)*
Additional 5000 Series Radiation Shielded X-ray Tubes							
93117	8232	Mo	4 - 50	1.5	75	1.7	170 Typ.
93025	8166	Ag	4 - 50	1.0	50	1.3	1000 Typ.
93006	8232	Rh	4 - 50	2.5	50	2.5	150 Typ.
93027	8187	Ag	4 - 50	1.0	50	1.3	1000 Typ.
93033	8203	Cu	4 - 50	1.0	50	2.4	250 Max.
93035	8166	Au	4 - 50	1.0	25	1.3	1000 Typ.
93046	8208	Mo	4 - 50	1.0	50	1.3	1000 Typ.
93066	8166	Rh	4 - 50	1.0	50	1.3	1000 Typ.
93072	8166	Ti	4 - 50	1.0	50	1.3	1000 Typ.
93080	8232	Mo	4 - 50	2.5	50	2.5	150 Typ.
93084	8166	Cr	4 - 50	2.5	50	2.4	150 Typ.
93138	8270	Rh	4 - 50	2.0	50	2.5	1000 Typ.
93302	8231	Mo	4 - 50	1.5	75	1.7	150 Typ.
93512	8166	Fe	4 - 50	2.0	50	1.4	1000 Typ.
Neptune 5200 Series Water-Cooled Radiation Shielded  See data sheet on page 20							
93211	8250	Mo	10 - 50	2.0	100	2.4	175 Max.
93212	8250	W	10 - 50	4.0	100	2.4	175 Max.
93215	8250	W	10 - 50	2.0	100	2.4	175 Max.
93221	8250	Rh	10 - 50	2.0	100	2.4	375 Max.
93402	8250	Mo	10 - 50	4.0	100	2.4	175 Max.
93403	8250	W	10 - 50	2.0	100	2.4	175 Max.
Apogee 5500 Series Radiation Shielded with Grid Control See data sheet on page 22							
93501	8243	W	10 - 50	1.0	50	1.7	35 Nom.
93500	8243	Cu	10 - 50	1.0	50	1.7	35 Nom.
93502	8243	Mo	10 - 50	1.0	50	1.7	35 Nom.
93504	8243	Rh	10 - 50	1.0	20	1.7	35 Nom.
93508	8243	Cu	10 - 50	1.0	50	1.7	35 Nom.
93510	8243	Cu	10 - 50	1.0	50	1.7	35 Nom.
93511	8243	Mo	10 - 50	1.0	50	1.7	35 Nom.
Pinnacles 50 kV Microfocus Radiation Shielded X-ray Tube See data sheet on page 16							
9400001	8062	Mo	10 - 50	1.0	12		10 Nom.

Part Number	Outline Drawing	Target	Operating Range (kV)	Max Anode Current (mA)	Max Anode Power (W)	Max Filament Current (A)	Spot Size (µm)*
Optima 93225 Integrated X-ray Source See data sheet on page 4							
93225	8277	W	30 - 50	1.0	50	1.7	150 Max.
Trinity Integrated X-ray Source See data sheet on page 6							
9100004	8100004	W	20 - 80	0.5	40		33 Max.
UltraBright Microfocus Source See data sheet on page 8							
96002	8236	Mo	20 - 60	2.0	60		18 Max.
96000	8236	Cu	20 - 60	2.0	60		18 Max.
96004	8236	W	20 - 90	2.0	80		18 Max.
96008	8228	W	20 - 90	2.0	80		18 Max.
Nova Water-Cooled Microfocus Source  See data sheet on page 12							
96013	8240	W	20 - 90	2.0	80		18 Max.
Other Industrial X-ray Tubes							
90046	8162	W	4 - 50	5.0	250	2.4	500 Typ.
90098	8162	Fe	4 - 50	5.0	200	2.4	500 Typ.

* Inquire for outline drawings, detailed specifications and exact spot size dimensions.
Max. = Maximum, Typ. = Typical, Nom. = Nominal

Summary

Oxford Instruments offers X-ray tubes with different anode materials designed to suit a wide variety of applications. The anode material defines an X-ray tube's characteristic spectrum. This application note shows the typical spectra of several different anode materials. The spectra provided are for reference only; your spectrum may differ from these according to the particular model of detector you are using, the geometry of your measurement setup, and the voltage and current on your X-ray tube.

X-ray Spectrum Theory

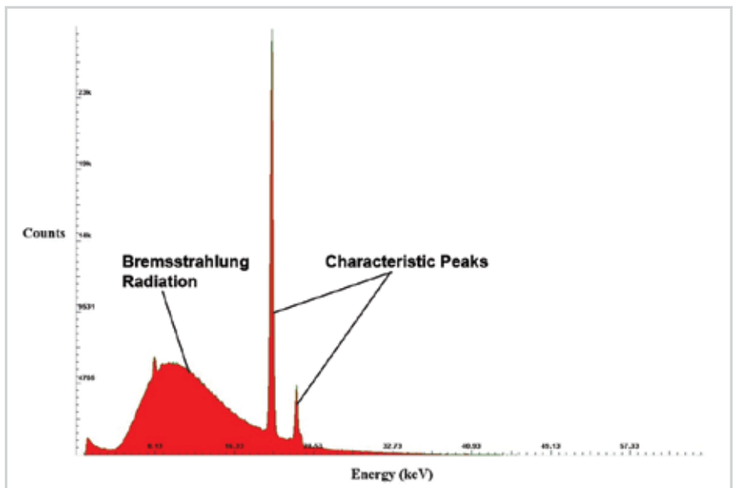
X-ray production involves bombarding a metal target in an X-ray tube with high-speed electrons that have been accelerated by tens to hundreds of kilovolts of electric potential. The electrons can eject other electrons from the inner shells of the atoms of the metal anode. Those vacancies will be filled when electrons drop down from higher energy levels and emit X-rays. These are known as characteristic X-rays and they have sharply defined energies associated with the difference between the atomic energy levels of the anode atoms. The Bohr atomic model predicts the energies of the characteristic X-rays. An X-ray spectrum is partially defined by the "peaks" or "lines" that result from bombarding different anode materials with highly accelerated electrons.

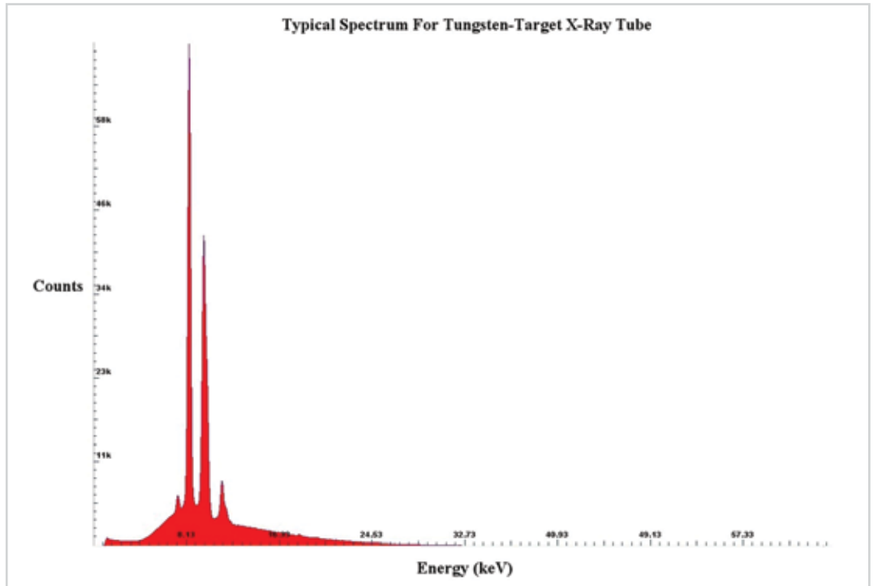
In addition to the characteristic peaks, an X-ray spectrum also has a background radiation pattern called the "Bremsstrahlung." Bremsstrahlung means "braking radiation" and describes the radiation that is emitted when electrons are decelerated through a metal anode. The deceleration leaves behind excess energy, some of which is emitted in the form of radiation. Decelerated charges give off electromagnetic radiation, and when the energy of the electrons is high enough, that radiation is in the X-ray region of the electromagnetic spectrum.

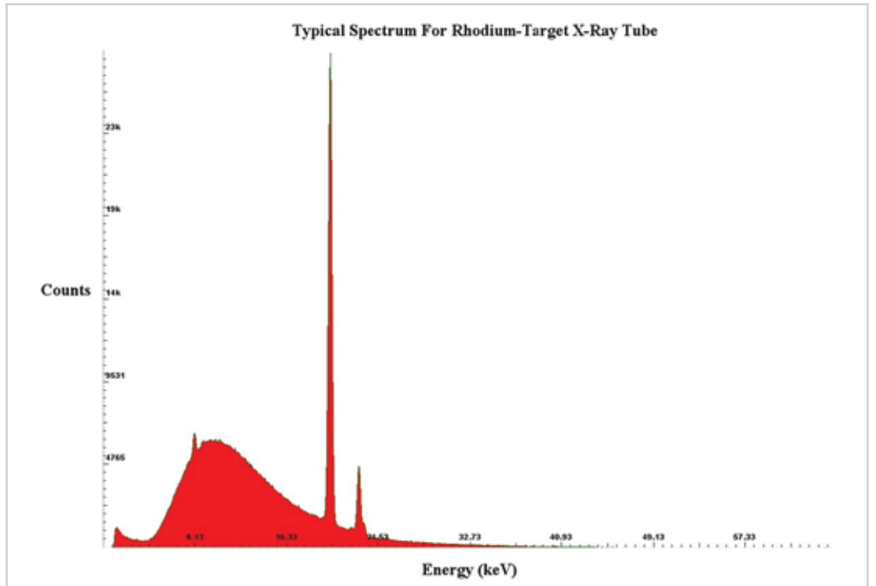
Thus, the X-ray spectrum that is emitted from your X-ray tube is a combination of the characteristic peaks of the specific anode material and the Bremsstrahlung radiation that is present in all X-ray tubes.

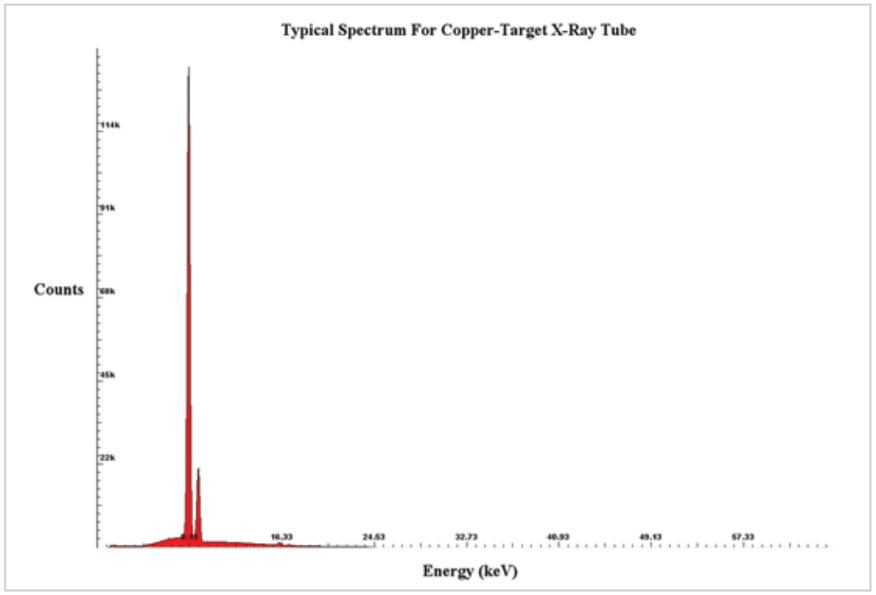
Experimental Setup

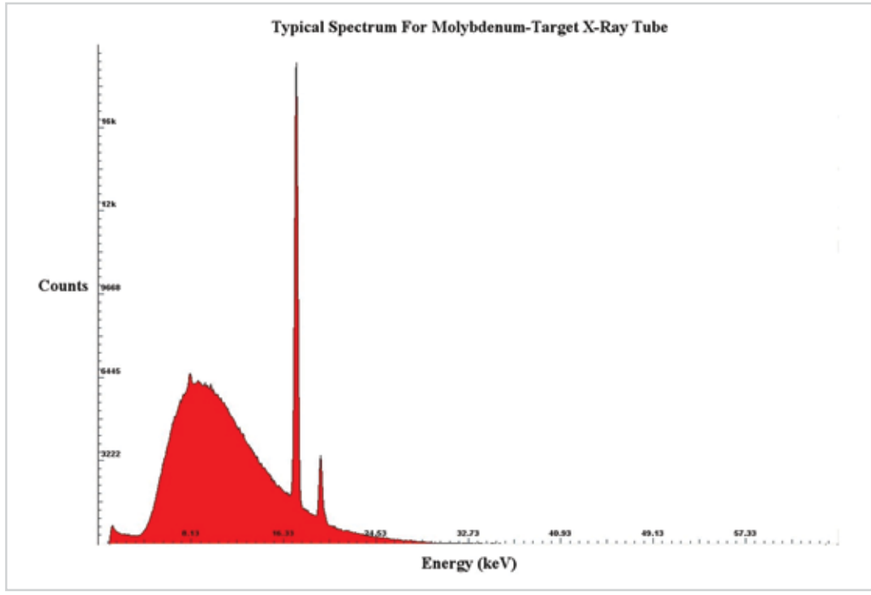
The following spectra were gathered by pointing Oxford Instruments X-Ray Technology's tubes directly at a Si-PIN photodiode detector system. There are a total of approximately one million counts in each spectrum.




Typical Spectrum For Tungsten-Target X-Ray Tube
Counts
58k
46k
34k
23k
11k
8.13
16.33
24.53
32.73
40.93
49.13
57.33
Energy (keV)


Typical Spectrum For Rhodium-Target X-Ray Tube
Counts
23k
19k
14k
9531
4765
8.13
16.33
24.53
32.73
40.93
49.13
57.33
Energy (keV)


Typical Spectrum For Copper-Target X-Ray Tube
Counts
114k
91k
68k
45k
22k
16.33
24.53
32.73
40.93
49.13
57.33
Energy (keV)


Typical Spectrum For Molybdenum-Target X-Ray Tube
Counts
96k
72k
9660
6445
3222
8.13
16.33
24.53
32.73
40.93
49.13
57.33
Energy (keV)

Summary

An X-ray tube is constrained in its operating range by four factors – maximum filament current, maximum power delivered to the anode, and maximum and minimum anode voltage. By operating your X-ray tube within these parameters, you may be able to achieve better results for your specific application while ensuring maximum longevity of your X-ray tube. This application note clarifies the constraints above and shows how an operating range is constructed. You can find all the particular values for your X-ray tube described in this application note on the datasheet.

Maximum Filament Current

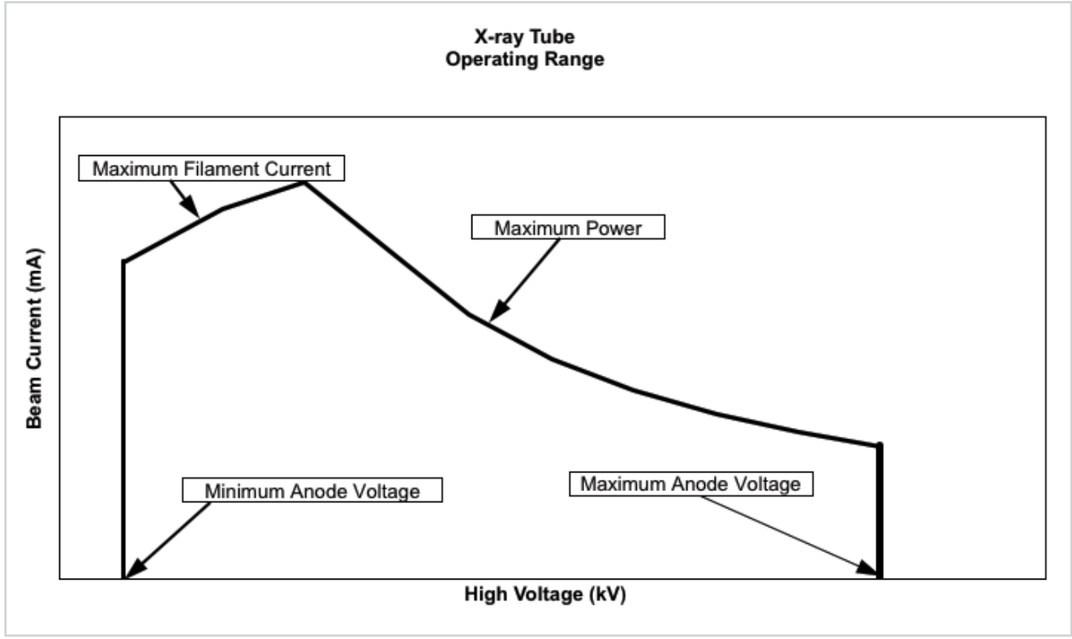
The maximum filament current is a very strict constraint that prevents the filament from burning out, just like the filament in an incandescent light bulb. Like any other wire, a filament will melt because it cannot dissipate the heat generated from excessive current. Oxford Instruments X-Ray Technology has conducted extensive testing to determine the maximum current the filament in your X-ray tube can withstand. A typical value is 1.7A, but this value varies by filament type and is given on the datasheet that comes with your X-ray tube. It constrains the first part of the operating range before the maximum power requirement takes over.

Maximum Power

Like the filament current limit, the power limit is a strict constraint that prevents the target from sublimating. An X-ray tube accelerates a very narrow beam of electrons to the target with a total power P = IV, where I is the beam current (not to be confused with the filament current – the current delivered to the filament itself) and V is the anode voltage. As you can see, this total power limit does not necessarily prevent using a higher beam current or voltage at a given power. Because beam current and voltage are inversely proportional in this relationship, raising one and lowering the other may still allow you to operate the X-ray tube within the maximum power constraint. Keep in mind that the anode voltage is limited as well, as detailed below. The maximum power constraint takes over after the filament limit is no longer a factor in the operating range.

Minimum and Maximum Anode Voltage

An X-ray tube requires a minimum high voltage applied to the anode in order to draw off electrons from the filament. When this condition is satisfied, the beam of electrons will form and accelerate towards the target. Below the minimum anode voltage, electrons will not be drawn off the filament, and thus the tube will produce no X-rays. At voltages lower than the minimum, some power supplies will overdrive (and potentially melt) the filament in an attempt to produce beam current when there are no electrons available. It is extremely important that you do not attempt to obtain beam current below this minimum anode voltage to avoid damaging the filament. On the other hand, the X-ray tube can only stand off a maximum high voltage applied to the anode. Beyond this voltage, arcing will occur and this can severely damage your X-ray tube. Both the minimum and maximum high voltages are sharp cut-offs that form the left and right edges of the operating range.



Conclusion

Some applications may require different settings than the typical “full power” at which most customers operate their X-ray tubes. By following the guidelines in this document, you may be able to achieve more desirable conditions for your application that still fall within the operating range constraints. In summary, to achieve the best possible conditions for your application, operate your X-ray tube within the constraints of maximum filament current, maximum power, and minimum and maximum anode voltage as described above.

Application

For X-ray tubes that have been in storage or inactive for a period of three months or more.

Description

After a period of not being used, typically three months or more, residual gasses are released from the internal surfaces of the X-ray tube and accumulate into the tube vacuum. If the maximum rated voltage (in kV) is applied after a period of storage without performing a conditioning procedure, permanent damage to the X-ray tube may occur due to the destructive nature of high voltage arcs in the ionized gas. The following conditioning procedure is appropriate for both "new tubes", as there may have been a period of storage, as well as tubes that have been stored for three months or more.

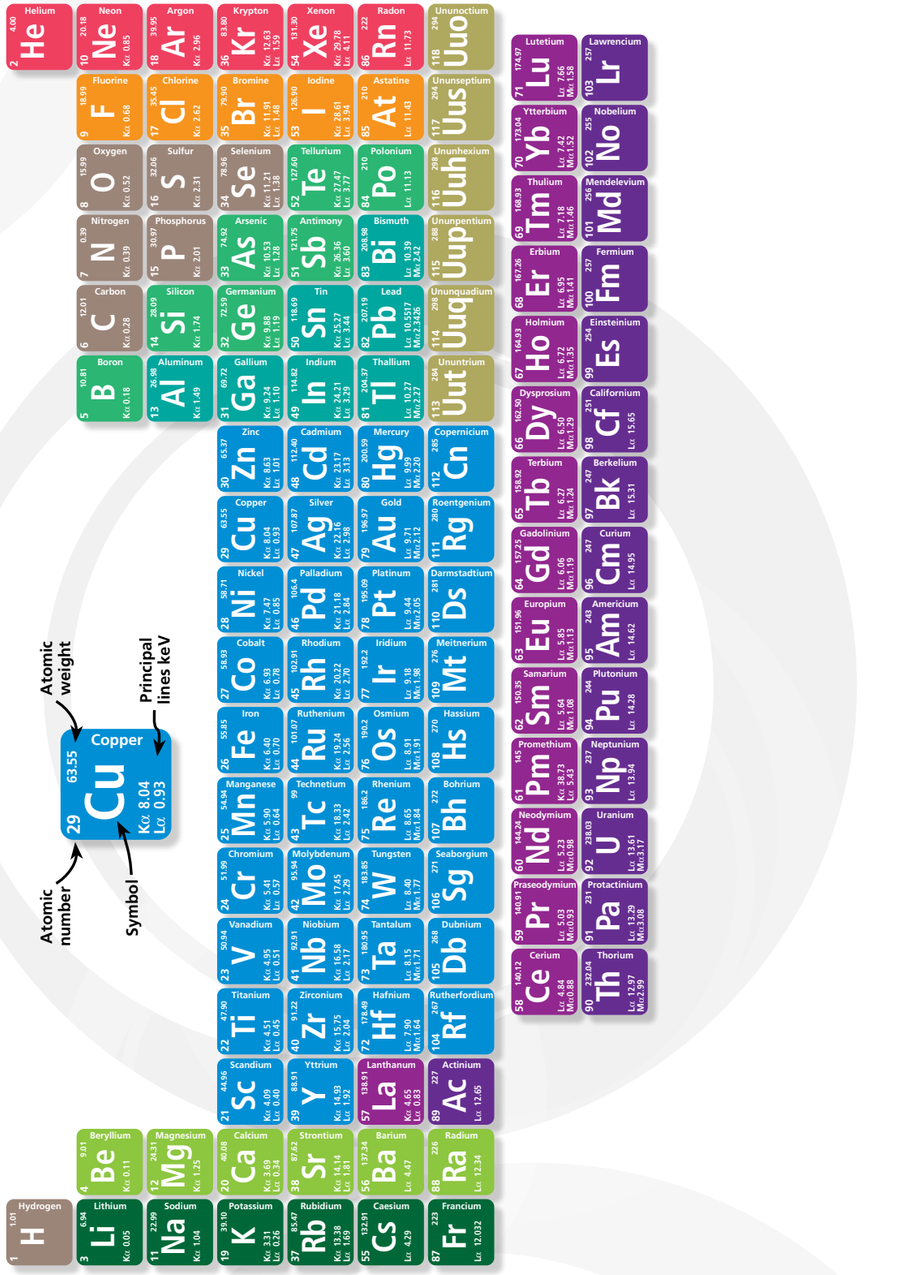
Procedure

To prevent this damage the following special conditioning process should be followed:

- Adjust the kV to the lowest kV that your specific tube is rated for. Set the beam current to 0 mA and if any instability is noted on the mA meter allow it to stabilize to display 0mA. Operate at this condition for a minimum of 15 minutes.
- While maintaining the kV set in the previous step, adjust the beam current to 20% of rated maximum. Maintain this setting for 5 minutes or longer, until no instability is noted on the mA meter.
- Increase high voltage in 5kV steps at 5 minute intervals until 50% of maximum rated kV is reached. Hold 5 minutes at these conditions.
- Increase beam current to maximum rated mA.
- Continue to increase high voltage as before, in 5kV steps every 5 minutes until maximum rated kV or your maximum operating kV is reached. Allow at least 5 minutes at full power to insure that the tube is operating correctly in your system.

Note

If instability (especially loud popping) is observed, lower the kV setting to the previous step. Allow mA to stabilize for at least 5 minutes before increasing settings again.



X-RAY

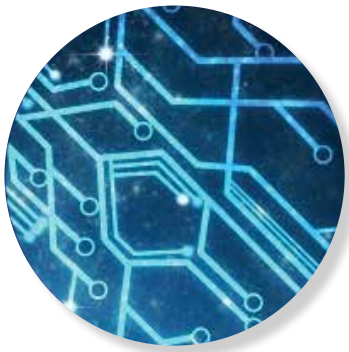
Oxford Instruments X-Ray Technology

X-ray Fluorescence

Scrap Metal Analysis

Clean Energy

Industrial Inspection



Printed Circuit Board
Drilling and Inspection

Food Safety

Medical Imaging

Extremity Imaging

Bone Densitometry

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